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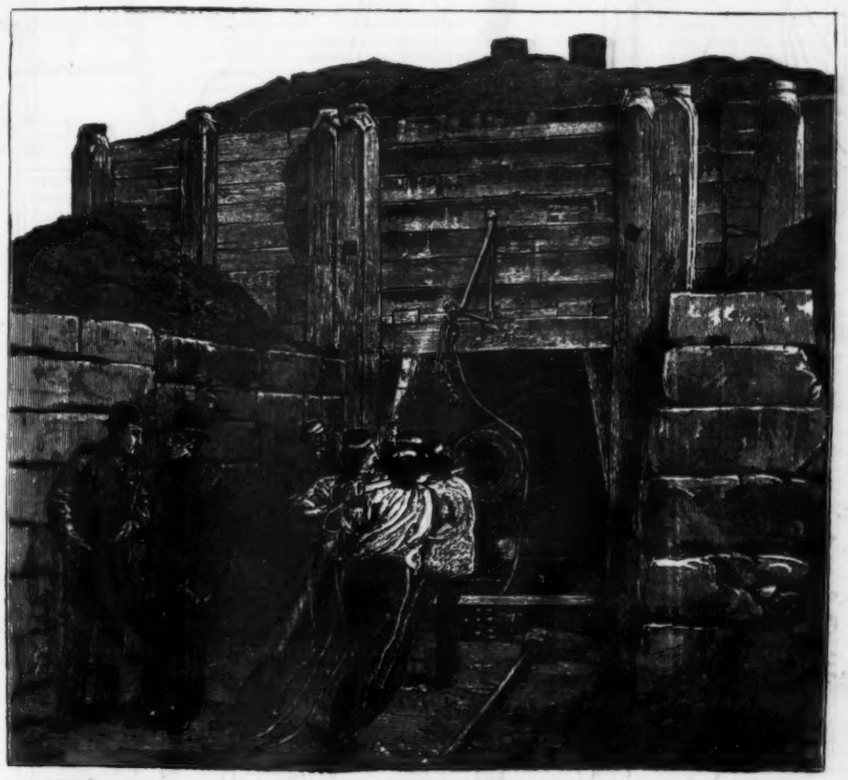
THE THUNDERER GUN EXPERIMENTS.

THE disaster which happened in gunnery practice on board H.M.S. Thunderer, on Jan. 2, 1879, at the Bay of Ismid, in the Sea of Marmora, has been repeatedly mentioned. One of the two great guns, each weighing thirty-eight tons, which were mounted in the fore turret of that ship, burst in firing with shell at a target, and the muzzle part of the gun was completely blown to pieces. Eleven men, amongst whom were Lieutenant A. H. Coker, R.N., Lieutenant Daniel, Royal Marine Artillery, and Corporal Bolton, with a gunner and seamen, were killed by the explosion, or by fragments of the gun, the shell, and the roof of the gun-turret. Both the burst gun and its companion piece, which remained uninjured, have been brought to Woolwich Arsenal; and the latter is now being subjected, in the Artillery Practice Marshes at Woolwich, to a series of experiments with overloading and irregular loading, for the purpose of ascertaining how such a gun is likely to burst if it be inadvertently or accidentally mismanaged.

We now give an illustration of the actual state of the burst gun, as it appears at Woolwich Arsenal.

These guns were manufactured by the Elswick Ordnance Company at Newcastle-on-Tyne, and were mounted with the working and loading machinery, on the hydraulic system, devised by Mr. G. Rendel, of that firm. Each gun was 19¼ ft. in length; the length of the bore itself was 16½ ft., and the diameter of the bore was 12 inches, rifled with nine grooves, upon the Woolwich increasing system, the twist being completed in a length equal to thirty-five times the width of the caliber. The guns were constructed on the Fraser system of shrunk wrought iron coils, having several short single coils and a forged breech-piece. They were fired with a charge of 85 lb. of powder and a projectile weighing 700 lb. It is considered probable that the gun was twice loaded, which naturally caused it to burst.

We also give an engraving showing the position of the companion of the burst gun, which, as before stated, is now being experimented with at Woolwich, under the direction of a government investigating committee.



The explosion had been caused, in the committee's opinion, by the gun having been inadvertently double loaded—first with a cartridge of 85 lb of powder and a Palliser shell of 700 lb., and then with a similar cartridge and a common shell of 587 lb.—the ignition of the foremost charge occurring at a part of the gun where the thickness of metal was inadequate to endure the strain. The Lords of the Admiralty on May 1 assented to the recommendation that the second 38-ton gun should be taken from the Thunderer's turret and subjected to a series of tests, in order to show that the accident was due not to any defect in the manufacture of the guns, but to circumstances entirely under the control of the gunners. One of the opposing theories was that the wad which is used to keep the projectile from slipping had by some means become displaced, causing the shell to jam, and so making the gun burst.

The 38-ton gun was placed in a cell in a mound facing the proof butts. It was mounted upon an ordinary naval carriage and platform, and all the arrangements were made to approximate as nearly as possible to circumstances on board ship. There was not much room to spare inside the cell, which was only about 10 ft. square at the front and some 30 ft. long, just sufficient to allow for the recoil. The interior is faced with balks of timber, overlaid with heavy pigs of iron and several feet of concrete, upon which earth is heaped until a hillock is formed 35 ft. in height and 200 ft. in circumference.

The experiments hitherto made have been chiefly designed to try whether or not the gun would burst with a considerable vacant space left between the powder cartridge and the shot or shell, as some persons were of opinion that, in the gun which did actually burst on board the ship, this derangement had accidentally taken place by the shell having slipped forward. It is now proved, however, that with an interval of six feet be-

THE THIRTY-EIGHT TON GUNS OF THE THUNDERER.

Canvas Canoes for Sailing and Paddling

Designed by W. P. Stephens

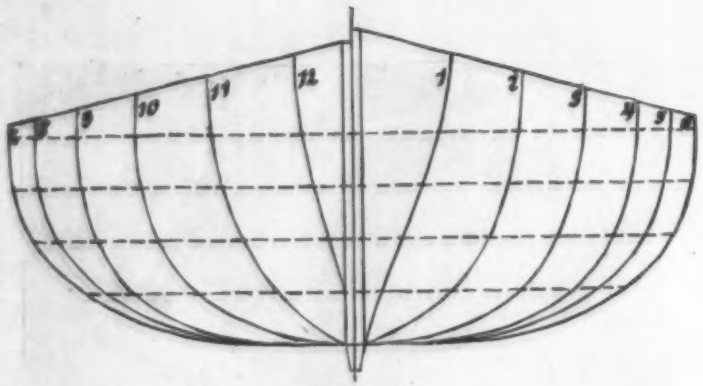


Fig. 7

Scale for Figs. 7 & 8

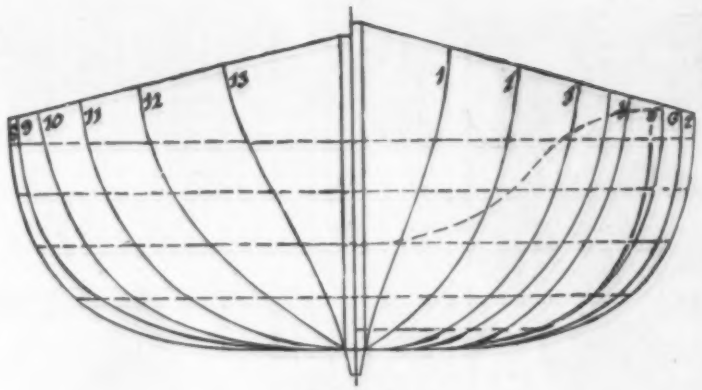


Fig. 8

Fig. 6

Fig. 5

Fig. 4

Fig. 9

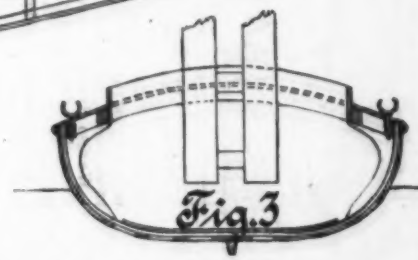


Fig. 3

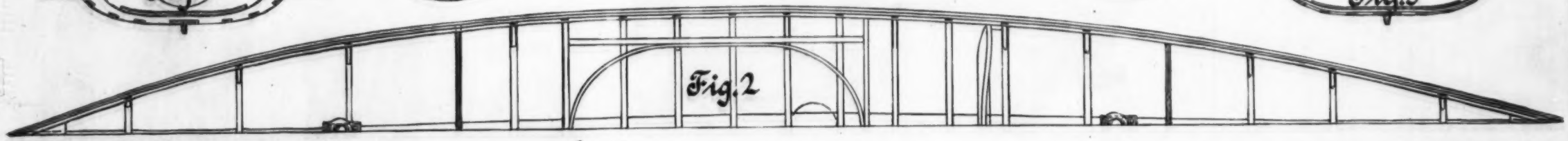


Fig. 2

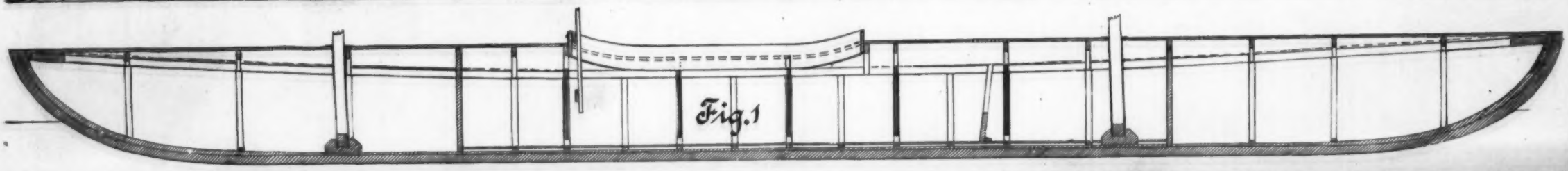


Fig. 1

tween the greatest charge of powder and the heaviest shot there is no injury to the gun, and the space will be increased to eight or ten feet, with little apparent probability of bursting. The committee will finally try if they cannot burst this gun by firing it with a double charge of powder and shells, as they suppose the other gun to have been twice loaded in the case of that lamentable disaster a twelvemonth ago.—*Illustrated London News.*

FINAL BURSTING OF THE SECOND GUN.

ADVICES from London, of February 4, state that on that day the final experiment was made which it was believed would settle the question as to how the first gun was bursted. The gun, for the purpose of this experiment, was loaded and fired with a double charge of 80 to 110 pounds of powder, one 600 pound common shell, and one 700 pound Palliser projectile. The gun burst, as its fellow did on board the Thunderer, thus justifying the opinion of the committee of investigation as to the cause of that disaster. The muzzle of the gun and the projectiles were buried in the sand at the proof butts. The remainder of the gun, with the exception of its base, was blown to atoms.

THE CONSTRUCTION OF CANVAS CANOES.

THE building of a canoe or other very light boat, of wood, requires not only considerable skill in the use of tools, but more technical knowledge of boat building than amateurs usually possess; so for the benefit of many new canoeists, who do not care to go to the expense of a wooden canoe at first, and of others, like ourselves, who prefer to build and equip their own craft, we will describe two canoes which can be built by any careful workman, and that, with reasonable care in construction and use, will make handsome and durable boats.

Though inferior in many respects to a wooden canoe, they will last a long time, one built by the writer in 1877 being still in use, and, after three seasons of rough usage, is apparently as sound as ever, and they have the advantage of being very cheap.

The larger boat is of similar model to the famous Baltic Rob Roy, of Macgregor, but has a little more sheer and greater bearings, making it stiffer under sail and better adapted for rough water.

Its dimensions are: Length on deck, 14 ft.; beam, 26 in.; depth at bow, 12½ in.; stern, 12 in.; amidships, 9 in.; well, 18 by 32 in.; draught, loaded, 5 in., including an inch keel.

This class of boat is the best known for river cruising, exploring, and general work, where light draught, portability, and easy paddling are the chief requisites; and is by far the best boat for beginners, but for coast work or bay sailing cannot compare with the Jersey Blue.

Fig. 1 shows the canoe in section and also its port side in elevation: Fig. 2 is the half-breadth plan, with deck and deck beams removed, except at well; Fig. 3 is a cross section amidships, and elevation looking aft; and Fig. 8 an enlarged body plan, giving the curves at distances of 1 ft. apart from bow to stern, those forward of midships being on the right and those aft on the left.

The smaller boat is better suited for a boy, and will do for hunting, fishing, short cruises, or to take when camping out, its length making it very portable.

It is 12 ft. 6 in. long, 26 in. beam, and 12, 11½, and 8½ in. deep.

Figs. 4, 5, 6, and 7 represent the same views respectively as 3, 1, 2, and 8.

For bending the ribs, keelson, combing, etc., a boiler and steam box are needed, but as they cannot always be obtained we give a method of building, shown in the drawings of the smaller boat, but applicable to either, whereby all bending is dispensed with; the boat being as strong and easier to build, but giving less room below decks.

The first step is to saw out from ¾-in. board two pieces for stem and stern; these are then screwed to the keelson of oak, ⅝ in. thick, 3 in. wide amidships, and tapering to ¾ at each end, the three being then set up on a bench or plank as described in SUPPLEMENT, No. 30, page 472, Fig. 37.

Next, the body plan, Fig. 7, must be enlarged as described for Fig. 35, by drawing lines 2 in. apart on a large sheet of paper, and laying off the distance from the center line to each point of intersection in the small drawing, six times on the corresponding line in the larger one, and drawing fair lines through the points.

Now take a pine board, ½ in. thick and 12 in. wide; mark and saw out the whole sections, Nos. 1, 2, 3, 4, 8, 9, 10, and 11 (leaving depth enough for the rise of the deck), and also saw out from oak or apple knees, two half sections each of Nos. 5, 6, and 7, the inner edges being of the shape shown in Fig. 4, joining each piece by a bottom. See Fig. 42.

Notches must now be cut in each section to admit the keelson and gunwales, and the latter, of oak, 1¼ by ⅝ in., halved into the stem and stern, and the sections put in place and secured temporarily

Now, the rib bands, 1 in. by ¼ in., may be planed up and tacked in place, being spaced amidships as in Fig. 4, and about equidistant at the ends, and the points where they cross each section and the stem and stern marked, after which they may be removed and notches cut to receive them, so that the outer surface of the stem, stern, keelson, gunwales, rib bands, and sections will be flush and smooth.

The whole framework should now be examined, and any alterations that may be needed to make the curves true must be made, as there will probably be some errors in enlarging the body curves from so small a scale; then the stem and stern being vertical and the sections square to the keel, all may be fastened together with brass screws or galvanized nails.

Now cut a piece of board to the curve of the deck (26 in. radius), and set it in place amidships, and with a straight edge and the eye trim each section to shape, then set in the ridge pieces (Fig. 5) of ¾-in. pine, and the side strips, over which the deck is stretched

The well is strengthened by a piece of oak or spruce, 1 in. by ¾ in., screwed to section 8 at one end and the deck beam, 1 in. by 1½ in., at station 5, and to the knees at 6 and 7.

The framework may now be removed from the stocks, and all inequalities planed down and the edges slightly rounded off, so as not to chafe the canvas, after which it is painted with two coats of white lead and oil, the canvas meanwhile being stretched on the floor and painted with a coat of raw linseed oil on the inside.

The canvas should be heavy, with a smooth hard surface, No. 4 Woodbury duck being a good size, and may be had of J. Boyle, No. 203 Fulton St., New York.

After the paint is dry, lay the frame in the center of the canvas, draw the latter around it, and secure it in place with a few tacks on the gunwales, then with a large needle and strong twine, sew both edges together with stitches about 8 in. apart, until the skin is laced over the frame as a shoe is over the foot.

When the string has been drawn tight, the canvas can be cut on bow and stern and tacked, being lapped and well painted, then go over the cord from end to end until every wrinkle is drawn out and the canvas is smooth and tight, when it may be tacked along the top of the gunwales, the cord removed, and the edges trimmed off, leaving about an inch, which is turned down and tacked inside the gunwales.

The canvas should also be tacked to each section intended to be watertight, which are Nos. 2, 3, 9, 10, and 11, the deck also being tacked to them when laid, thus forming watertight compartments and lessening the damage in case of a rip or tear.

The floorboards, ⅜ in. thick, of pine or spruce, can now be screwed to the bottoms, the blocks for the footboard or stretcher, the mast step, and the combing of ¼ in. oak projecting 1½ in. above the deck, put in when all is ready for the decking, this having been also oiled.

A heavy drilling or light duck, 28 in. wide, will answer, a hole being cut out for the well (leaving enough to turn up and tack around the combing), and the edges are tacked to the outer side of gunwales, lapping over the outer canvas.

The boat should now have two or three coats of paint, each having time to dry, then a half round strip of oak, ¾ in. diameter, is screwed along each gunwale.

The outer keel is of oak, 1 in. deep, ¾ in. thick at back, and ⅜ in. on face, and must be bent; but if there are no facilities for steaming, it may be made from two shafts or sleigh runners, which may be had ready bent at any wheelwrights, and which should be first procured and the stem and stern piece cut to fit them.

The two pieces are scarfed in the center and screwed to the stem, stern, and keelson.

Now lay the boat on a level floor and mark where each bilge touches, and screw on each side a piece of oak, ¾ in. by 1¼ in. and 4 ft. long, to protect the bottom. Holes are bored in stem and stern for the painter, and the boat is ready for the fittings described below.

Circular holes in sections 4 and 8, Fig. 5, give room for stowing small articles.

If the amateur wishes to build a lighter and roomier boat, he must first rig up a boiler and steambox, as described in SUPPLEMENT No. 30.

The keelson, stem, and stern are in one piece, of oak, 3 in. by ¾ in. amidships, tapering to ¾ in. by ⅝ in. at ends, steamed, and bent to the curves shown in Fig. 2.

The piece is set up as described, and sections 8, 10, and 3½ cut out of ½ in. pine and put in place, the latter two forming permanent bulkheads, the other being removed as soon as the ribs and deck beams are in.

The gunwales and rib bands are now tacked in place, and the points where they cross the stem, stern, and bulkheads marked, and notches cut, after which they may be screwed together.

The rib bands next the keel are 5-16 in. thick, the others and the outer gunwales being ¼ in.

A wedge of pine, 4 in. long, is fitted between each pair of rib bands at stem and stern, and screwed to them.

The ribs are of oak, ⅝ in. by ¾ in., steamed and bent; a number being prepared of various curves, barrels or any round objects being used to bend over them; the one nearest the shape required for any position is selected from the lot, and if it does not quite fit it may be bent back while cold without injury.

They are fastened by a copper nail through each rib band, riveted over a burr or washer, then after all are in, an inwale of oak, 1½ in. by ½ in., is notched over each rib and riveted to the outer gunwale.

The mast steps are now put in, also the blocks for the stretcher, and the sockets for the steering crutch, and the floorboards of 5-16 in. pine screwed to the ribs or made movable, as in No. 164 SUPPLEMENT.

The deck beams of oak, 1 in. by ½ in., are next screwed to the gunwales and strengthened by knees, other knees being placed so as to support the well, and screwed to the side pieces, all being strongly fastened, as this is the weakest part of a canvas boat.

The frame should now be smoothed off and painted, the canvas laced and tacked on, the keel bent and screwed on, and the bilge guards put on as described.

The combing may be bent, as many prefer the oval well to a square one, it being more ornamental but no stronger.

The deck may be laid as above, but a better plan is to lay a thin pine deck, and after painting it, lay on the drilling while the paint is wet, tacking on the outer edge and around the combing, and then putting on the gunwale strips, as in the smaller boat.

The backboard is 17 in. long, Figs. 1 and 3, and is hung by a strap to the combing, and the stretcher is shown by dotted lines in Fig. 8, and rests against a cleat on the floorboards and a block on each gunwale.

A hatch of light wood is sometimes fitted over the well, but it is generally much in the way, a better plan being a piece of rubber cloth, fitting around the body and tied with loops of light twine to screw heads around the combing, so as to come off in case of an upset, the ends being tucked in between the body and the backboard.

No plan should be adopted that will not allow the canoeist to free himself instantly in an emergency.

The masts should step in copper tubes, both to keep water from entering around them and to preserve the deck in case the mast should rise from the step.

For the smaller boat the rig devised by Macgregor is used, the sail being of the shape shown in Fig. 10. Mast, 1¼ in. diameter, tapering to 1 in., 5 ft. 6 in. long; boom and yard each 4 ft. 9 in. long; luff, 2 ft.; leech, 6 ft.; the sail being of unbleached sheeting, the rigging of woven cord or trolling line, and the spars of spruce.

The boom is fastened to the mast by a piece of soft leather lashed to both, allowing movement in all directions.

The mast in the old Rob Roy is stepped, as shown by the dotted lines in Fig. 10, so that the boom will clear the canoeist's body, but this has the great disadvantage of a strong lee helm, the only gain being that in jibing the beam pokes you in the eye or caresses the bridge of the nose, instead of striking the side of the head, as it would if stepped farther

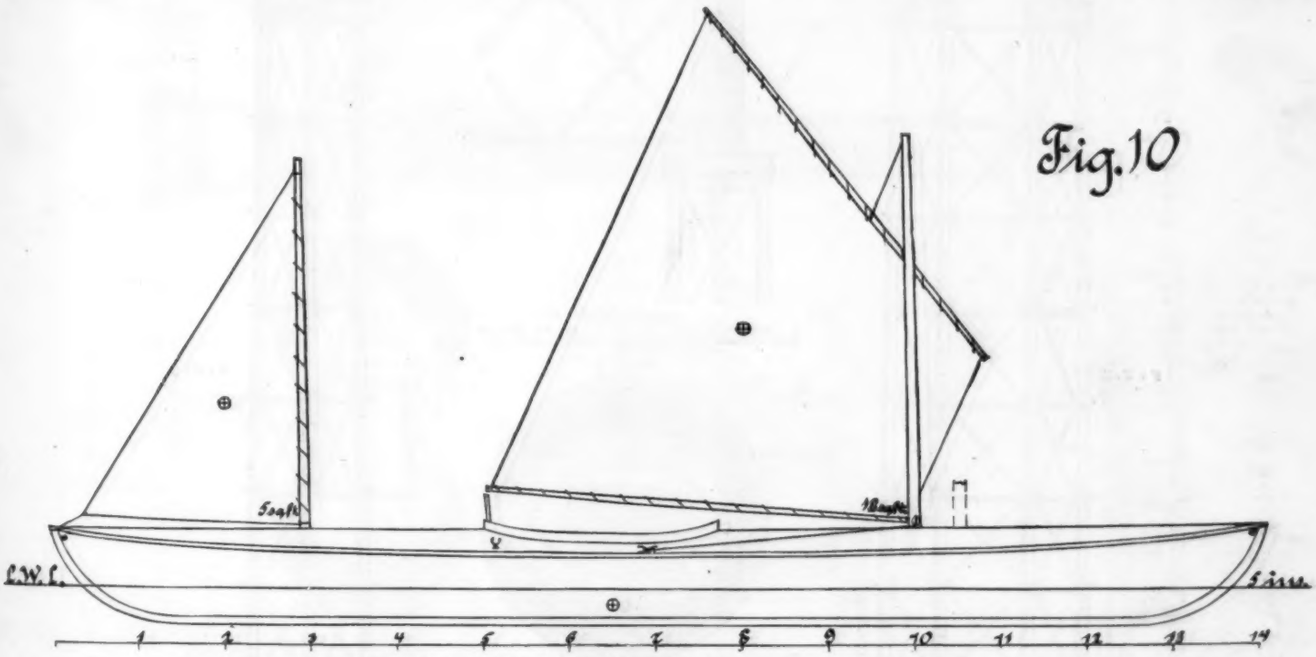


Fig. 10

CANVAS CANOE.—DESIGNED BY W. P. STEPHENS.

aft; so to give more weather helm, and so allow the paddle to be held to leeward in steering, the mainsail of the larger boat is stepped farther aft and a dandy added, the latter not being used in running free.

The dimensions are: Mast, 5 ft. 6 in.; boom, 4 ft. 9 in.; yard, 5 ft. 2 in.; leech, 6 ft.; luff, 2 ft.; dandy mast, 5 ft. 2 in.; sail, 4 ft. on luff, 4 ft. 5 in. on leech, and 2 ft. 6 in. on foot.

No jib is used, as it is a constant nuisance and seldom of much use.

The paddle is of one piece of spruce, 7 ft. long, 6 in. to 7 in. wide, 3-16 in. thick at the edges, 1 in. diameter at center, and ⅞ in. by ¾ in. at neck, bound with copper, and having rings of rubber to prevent the water dripping down.

For steering the paddle is used in a "crutch" or rowlock, being shifted to leeward in going about, a stroke or two also being needed to help her when "in stays."

When paddling to windward the sails and spars may be stowed below decks.

Cleats are screwed to the deck for the halyards, and a hole should be cut in the flooring to bail through with a sponge, being just between the canoeist's knees.

The builder may vary the model to suit his taste by setting up the keel, stem, stern, and midship mould, and putting on the rib bands, securing them in the curves he wishes, and fitting the ribs or sections to them. This mode of building will answer equally well for any light craft with rather full lines, as of course the canoes cannot be tightened over a concave surface

Care must be taken in building to have no sharp points or corners to cut the canvas, to keep the pieces square and in their proper positions until fastened, and also to put in the deck beams before putting on the canvas, so that the frame cannot spread.

A hole should be made in each compartment to air it when not in use, being closed with a plug, and no water should be left in after using, and the boat should be housed.

With these precautions, and touching up the paint from time to time where it may rub off, such a boat will last a long time.

Should any further information be desired the writer will be happy to furnish it.

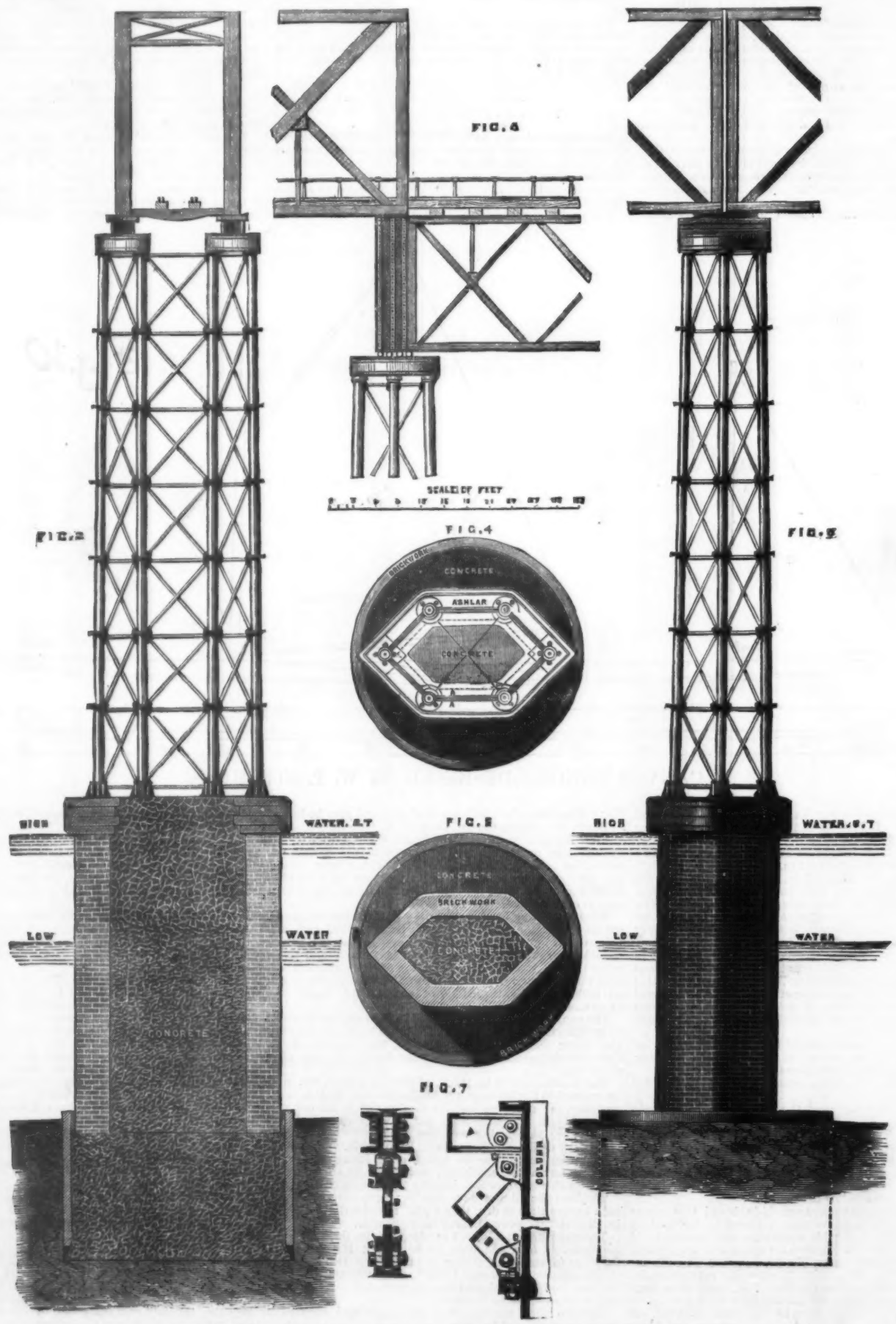
W. P. STEPHENS.

Rahway, N. J.

THE TAY BRIDGE.

WHILE the Government inquiry into the destruction of the Tay Bridge (Dec. 28, 1879) is in progress, it is inexpedient to express any positive opinion concerning the cause of that catastrophe; but we should scarcely do our duty by our readers if we did not put them in possession of all the facts concerning the bridge itself which are available. We give this week, therefore, drawings which will serve to make the construction of that portion of the bridge which has failed perfectly clear; and we supplement these with additional drawings, showing the contiguous portions of the structure which have sustained no damage.

Some persons, whose geographical knowledge is imperfect, have a vague idea that the Tay Bridge is a link uniting England and Scotland; and it may be as well to explain here once for all that Dundee lies north of Edinburgh about thirty-five miles, and north of the Border by more than sixty miles as a crow would fly. It stands on the north shore of the estuary of the river Tay, which opens into the North Sea. The Tay flows almost precisely from east to west under the bridge, that portion which was destroyed running very nearly due north and south. The Firth of

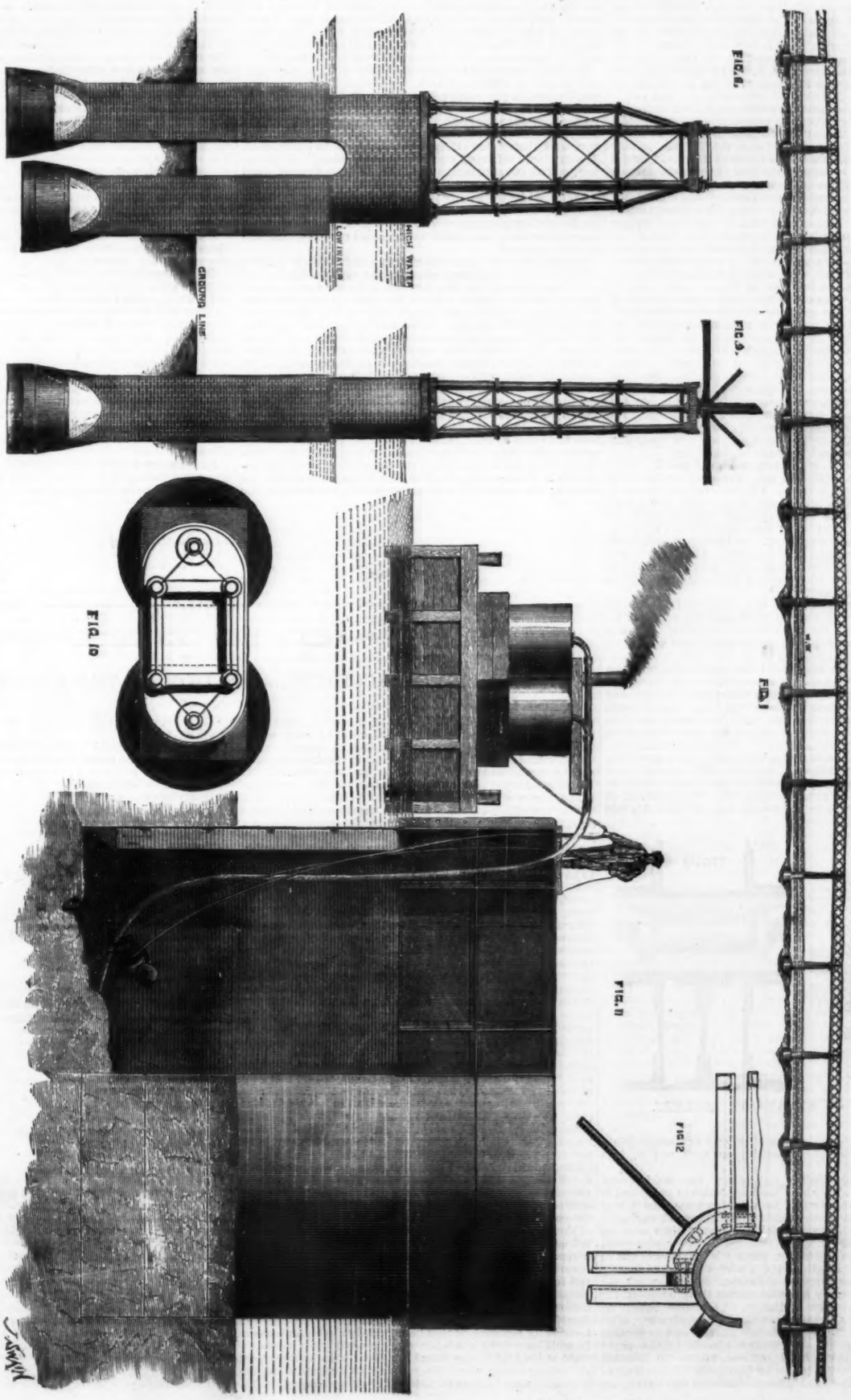


THE TAY BRIDGE.—PIERS OF THE PRINCIPAL SPANS.

Tay runs inland about twenty-five miles. The exact position of the Tay Bridge, of Dundee, and of Broughty Ferry, and the direction of the railways which the bridge united, are best seen in a bird's-eye view.

Our engravings—all drawn to scale—give an elevation, Fig. 1, of the thirteen girders with their piers which have been destroyed; Figs. 2, 3, 4, and 5 are side and end elevations and plans of the piers which supported the girders; Fig. 6 shows the union of the 245 ft. girders with those of 145 ft. span on each side; Fig. 7 is a section of one of the column joints; B B are the diagonals, secured in the double lugs, C C; the horizontal braces are of channel iron, A A. Figs. 8, 9, and 10 show the piers of brickwork which were first adopted—fourteen of these piers have been constructed on the Fife side; Fig. 11 shows the method used in sinking the foundations for the main piers, Figs. 2, 3, 4, and 5; and Fig. 12 shows in detail the plan of the horizontal braces of the main columns. The foundations of the main piers were constructed on shore. They consist each of a wrought iron cylinder made of plates ¼ in. thick. Each cylinder is 31 ft. in diameter and 21 ft. deep. The lower edge is provided with a curb, as shown, consisting of an angular ring riveted to the external cylinder, the space between the two being filled in with liquid cement or grout. This was known on the works as "the grout ring." On this grout ring was built up, all round, brickwork laid in cement, 15 in. thick. So far we have the permanent caisson. On top of each was bolted the temporary caisson, Fig. 11, to which were riveted four vertical T irons. The holes in these served for the attachment of sling chains. When the permanent caisson, with its brick lining and temporary caisson, was ready it was lifted between two barges and floated out on the top of the tide to the proper place. It was then lowered gradually by hydraulic machinery until it rested on the bottom, which in this part of the river was almost wholly of sand. A diver then descended within it, and the ingenious apparatus invented by Mr. Reeves was put into use.

We have already described this apparatus; but nothing will be lost by explaining once more that it consisted of two vessels, from which the air could be withdrawn by an air pump 12 in. in diameter and 12 in. stroke, worked by a steam engine with a 7 in. cylinder and 12 in. stroke. The vessels or tanks each had a capacity of 60 cubic feet. With each was united a hose; one end of this was manipulated by the diver as shown in Fig. 11. One of the tanks being exhausted, a valve was opened, and sand and water were together raised at once by the pressure of steam and water, and at such a rate that not more than three minutes were required to fill a tank. The work of sinking the piers with this apparatus proceeded very rapidly.



THE TAY BRIDGE.—ELEVATION OF MAIN SPANS AND DETAILS.

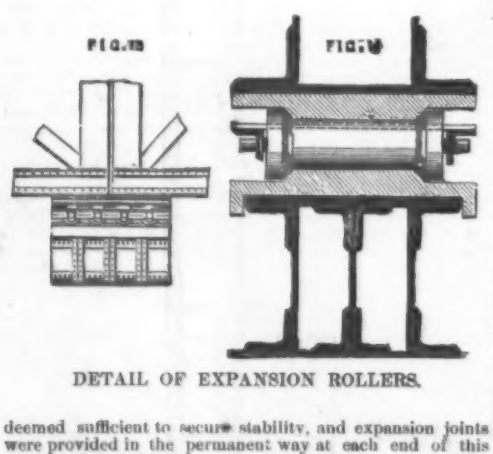
rubble stones being shot round each outside to prevent external scour the moment a pier had fairly sunk a little way into the bed of the river. The process of sinking was continued until each caisson had fairly grounded on the true bed of the river. This done, the center was at once filled up with cement concrete. On the foundation thus obtained were erected the brick piers. These are flat at the sides and pointed at the ends, as shown in the plan, Figs. 4 and 5. They are 27 ft. long and 16 ft. broad. The piers were built up on shore to a height of about 22 ft., and left hollow. They were then floated out between barges, like the foundations, and were dropped into place on the top of the concrete in the 31 ft. cylinders. They enter these cylinders to a depth of about 2 ft., and the space all round was then filled in hard with cement concrete. The top of the brickwork came a little above low-water mark, and it was built upon, tide by tide, till the proper level had been reached—5 ft. above high-water mark—when a stone coping, consisting of four courses, each 16 in. thick, was put on. Through this coping, and through it alone, the holding-down bolts of the main columns extended; so that the stability of the pier above the water depended on the hold which the uppermost stone cap had of the brickwork and concrete of the lower portion of the pier. The hollow in the center of the brickwork was filled in with concrete, so that the whole from the bed of the river to 5 ft. above high-water mark may be regarded as a solid mass of brick in cement and cement concrete.

On the top of each brick pier was erected an iron pier, consisting of six columns of cast iron made in 10 ft. lengths, as shown in Figs. 2 and 3. To these drawings we direct particular attention. It will be seen that of the various sections or stories each one is complete in itself, and united to the next below it only by the pins through the flanges. These pins were eight in number in each joint, and 1¼ in. in diameter. The columns were all cast at the side of the river in a foundry built for the purpose. They were made, we understand, of selected Cleveland iron. The flanges were turned, and joints faced. The holes were drilled, and to allow for the inequalities in the castings washers were put under the nuts—as many as half a dozen being sometimes used. The columns were filled up with cement grouting. A joint is shown in detail by Figs. 7 and 12. It is obvious that the stability of the structure depended entirely on the strength of the columns and of their connections, the bolts; and we have no doubt that the strength of the joints will be carefully investigated during the present inquiry. It is due to Messrs. Hopkins, Gilkes & Company that no uncertainty should be suffered to remain concerning—(1) the good quality of the bolts, (2) that they had fair play, (3) concerning the quality of the metal in the columns, (4) concerning the concentricity of the inside and the outside surfaces of the columns, and (5) concerning the soundness of the castings, especially about the flanges. There can be no difficulty in obtaining plenty of specimens to settle these points from the ruins of the bridge.

The shorter columns are shown in Figs. 8 and 9. They were constructed in a different way, already fully described in our issue of April 3, 1873. The foundations consist of cast iron casings, with bell-shaped feet, within which men worked, the whole tops of the cylinder being closed by air locks. The double piers below were united above by brickwork, as shown in our engraving. On the top of each brick pier is built up a cast iron pier, as shown. Originally it was intended that these piers should each have only four columns, but two raking columns were subsequently added to each to increase their stability.

Of the main girders, eleven were each 245 ft. long, and two were 227 ft. long, the depth of all being the same—27 ft. The triangulation of the girders was very open. The top and bottom booms were of the trough shape, and about 2 ft. wide.

Where the main girders joined the rest of the bridge, a species of step, so to speak, occurred, the top of one set of girders being level with the bottom of the next. To get over this, a heavy box transverse girder was secured to the ends of the 145 ft. girders; and on this box rested the ends of main girders; rollers for expansion were interposed below. The whole arrangement is shown in detail in Fig. 6. No attempt was made at any place to anchor down the main girders. Each 245 span, complete with two side girders, cross girders, and top bracing, weighed approximately 200 tons, and this weight, combined with the grooving in the expansion rollers, as shown in Figs. 13 and 14, was



DETAIL OF EXPANSION ROLLERS.

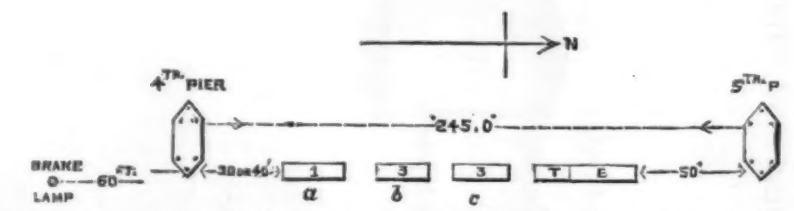
deemed sufficient to secure stability, and expansion joints were provided in the permanent way at each end of this portion of the bridge.

It may not be out of place to say here that nearly every account of this bridge which has been hitherto published is more or less untrustworthy, because from the time it was begun until the time it was finished, all concerned, engineers and contractors alike, were making compromises with the difficulties encountered. If it was found that a pier could not be got in precisely at the place wished, it was put in elsewhere; and the length of the girder was altered to suit. If any reason was thought sufficient, the design of the bridge was immediately modified during the progress of the work without the least hesitation. Thus one bowstring girder was put in to cross a proposed esplanade; but, after a time, the site of the esplanade was altered, and so another bowstring was put in. Mr. Gilkes himself, in the paper from which we have already quoted, makes no mention whatever of the two 127 ft. spans, but speaks throughout of thirteen 245 ft. spans; and other instances of inaccuracy are not wanting in various quarters. In short, no complete description of the whole structure *as finished* has ever been published—a fact much to be regretted, as such a description would be invaluable for the purposes of the present inquiry.

The girders were raised to their places as the piers were erected by a process which we describe in Mr. Gilkes' own words: "The raising of these spans, simultaneously with the erection of the piers, again called out a rather novel application of the hydraulic ram. The process is this: Four columns and their bracings are fixed in their positions on each pier. These are followed by a second tier of four, also braced and tied together. To the upper set of columns wrought iron cross girders of great strength are attached, and on these hydraulic rams are fixed, with which the combined span of girders is slowly raised up, much in the same manner, and with the same precaution of lifting and holding pins as adopted in lowering the caissons. In this way the span, weighing about 200 tons, is lifted up as the piers are built—the final lift being given from extra columns that overtop the whole structure of the pier. After the girders are at their greatest elevation, the cutwater columns are erected and braced to the other, and the whole pier is consolidated and completed, the girders being, at the same time, settled in their final position. The apparatus of lifting girders, hydraulic rams, etc., is then removed to another pier."

Mr. Gilkes gives the area exposed to the wind for each span and its pier as 1,600 ft., which, multiplied by 60 lb. for the wind pressure per square foot, gives 43 tons as the overthrowing effort of the wind on any span. He wrote thus on the subject in November, 1876: "A consideration of the action of the wind on this bridge will dissipate the often-advanced theory that at some period it will be blown over. The exposed surface of one large pier is about 800 square feet, and of the superstructure which depends upon it about 800 more; and so, giving 800 ft. for a train above, we have 2,400 ft. 21 lb. per square foot is the force of a very strong gale, but it would take no less than 96 lb. per square foot on the surface given to overturn the pier. Even the most severe hurricane on record would equal only one-half this resistant power."

Now, 96 lb. on the square foot acting on 2,400 ft. of surface represents an overturning effort of not quite 103 tons, and would give about four times as much for the tensile strain put on the lower flange bolts of the piers, from which must be deducted the insistant weight of, say, half the pier and one-fourth of the girder. This would leave about one hundred tons for each of the three upright windward legs to sustain. The eight bolts would represent, say, 8 square inches of section, which, multiplied by 20, would give 160 tons. Thus the bolts *ought* not to be the first to go. Again, the three legs would have a sectional area of, let us say, 50 square inches each. The strain would therefore be not more than two tons per square inch—not too much for good cast iron. We are at a loss to know on what data Mr. Gilkes' statement was based. Whatever were his grounds, the suggestive fact remains that, whereas it is known that wind pressures of at least 50 lb. to the square foot have been recorded in this country, the Board of Trade consented to the opening for traffic of a structure which, according to the public statement of one who ought to know best, had a factor of safety of much less than two to one. In other words, it was known that the bridge might be exposed to gales which would strain it to more than half its breaking strength, and yet it was deemed fit for traffic. But the officers of the Board would not for a moment sanction the running of trains across a girder, the calculated breaking strength of which was 96 tons, if the strain due to the rolling load and dead load reached 50 tons. The anomaly requires some explanation. If Mr. Gilkes is right, and the breaking or overturning point, due to the wind, was 96 lb. on the square inch, then the Board of Trade, to be consistent, ought not to have permitted the use of the Tay Bridge by the public.



THE TAY BRIDGE ACCIDENT.—POSITION OF THE WRECKED TRAIN.

It is not easy to ascertain the precise position of the wrecked train, or of so much of it as exists in a recognizable form. The evidence of the divers contains all the available information, and this is at best scanty and imperfect. We believe, however, that the annexed diagram shows pretty accurately the extent of information acquired on this part of the case. The diver Simpson has testified to the position of the engine, tender, the third-class carriage, *c*, and the first-class carriage, *a*. The engine, he says, lies about 50 ft. south of the fifth broken pier, counting from the south. The tender is attached to it, and the carriage, *c*, is close to. Then he speaks of carriage, *a*, as being a little to the north of the fourth pier. Fox, another diver, says it was about 40 ft. to the north, and Thomas says about 30. The last-named diver found to the north of the first-class carriage, *a*, and "close to it," a third-class carriage. From the description he gives of this carriage it is clearly not the same carriage as *c*, discovered by Simpson. It is therefore the second third-class, *b*.

So far the evidence seems consistent and probable. The length of the engine, tender, and three carriages would be, according to Mr. Drummond's figures, 158 ft., or thereabouts; adding to this 50 ft. and say, 35 ft., the spaces spoken to by the divers as existing between the respective piers and the vehicles nearest to them, we have 243 ft. lying in the span between the piers of 245 ft. Then Simpson found one of the van side lamps at a spot between 50 ft. and 60 ft. south of the fourth pier, fairly showing that the rest of the train fell on that side of the pier. Norly, another diver, however, is reported as giving a circumstantial account of the discovery by him of a first-class carriage between piers three and four. Now there was only one first-class carriage in the train, and we have a concurrence of testimony as to the position of its ruins to the *north* of the fourth pier; we are therefore compelled to assume either that Norly has been incorrectly reported, or that he is mistaken in his statements. In addition to the van lamp, roof lamps to the number of eight at least have been found by the divers on the south side of the fourth pier. They, no doubt, represent the two carriages which fell on that side.—*The Engineer.*

THE MILLERS' INTERNATIONAL EXHIBITION.

CODE OF REGULATIONS FOR THE TEST TRIALS OF AUTOMATIC CUT-OFF STEAM ENGINES, AT THE MILLERS' INTERNATIONAL EXHIBITION, CINCINNATI, JUNE, 1880.

THE ENGINES.

ALL engines entered for trials will be uniformly 18 inches diameter of cylinder and worked at 600 feet piston speed. The drop cut-off engines should be 18 x 48 inches (unless the builder prefers a longer or shorter stroke), and worked at 75 revolutions per minute.

The pulley fly wheel for drop cut-off engines should be 16 feet diameter, and 25–26 inch face, or adapted to a 24 inch belt. Should any builder prefer to use a smaller wheel, not less than 14 feet diameter, he may do so by promptly advising the expert of the size wheel he will use. But in each instance if possible a 16 foot wheel should be used. Engines having other than 48 inch stroke, will make diameter of fly wheel equivalent in diameter to 16 foot wheel at 75 revolutions per minute.

Each cylinder shall be drilled and tapped by the builder for indicator connections. This will be for ⅛ inch pipe. The center of holes (one at each end of cylinder) shall be opposite center line of cylinder, and center of width (or length) of cylinder clearance space. Each cross head shall be drilled and tapped ⅝ inch (machine thread), 1 inch deep, for attachment of indicator driver. This hole shall be opposite center of cross-head pin.

Each cylinder shall be drilled and plugged at both ends, for taking the clearances of cylinder and steam passages. The upper holes must be so situated as to permit the filling of spaces with water to the highest point, and the lower holes must be so situated as to completely drain the spaces after they are filled. The holes should be for the reception of ¾ inch pipe. The clearances will be measured previous to the trials with cylinder hot.

Each competitor will be allotted a space 20 feet wide and 35 feet long, in which he will build his foundation under the direction of the expert.

Each competitor will be required to furnish his connections with the main steam pipe, with the main injection pipe, and with the main overflow pipe.

Steam will be furnished the engines one week previous to the opening of the Exhibition, for the purpose of testing steam joints, adjustment of valve motion, bearings, and regulation.

All steam joints, piston packing, and valve joints must be practically steam tight before the engine is submitted to trials. The fit of piston packing will be determined by removing back cylinder head, setting crank on forward and back centers and subjecting piston to steam pressure at 90 pounds by gauge.

It is expected that all pistons will be steam tight under this test.

Each engine must be furnished with complete condensing apparatus, including a by-pass valve to change from condensing to non-condensing engine.

Each competitor will file with the expert a summary, showing the

Diameter of cylinder to nearest 0.01 inch.
Stroke of piston to nearest 0.01 inch.
Diameter of piston rod to nearest 0.01 inch.
Diameter of steam pipe.
Diameter of exhaust pipe.
Area of steam ports (each).
Area of exhaust ports (each).
Diameter of fly wheel.
Face of fly wheel.
Weight of fly wheel.
Weight of engine exclusive of fly wheel.
Diameter of injection pipe.
Diameter of overflow pipe.
Diameter of air pump.
Stroke of air pump.
Manner of working air pump, and any special points of merit possessed by the engine.

THE TEST TRIALS.

The boilers furnishing steam for the trials—two in number—are each of the following dimensions:

Diameter of shell		48 inches.
Length of shell		16 feet.
Tubes		32—4 inch.
Heating surface shell	114·80	
Heating surface tubes	536·16	
Heating surface heads	12·56	
Heating surface total	1,327·24	sup. feet.
Grate surface total	35·33	"
Heating to grate surface, ratio	37·58	
Grate surface to calorimeter, ratio	6·327	

And are calculated to furnish 4,500 pounds of steam per hour at 90–100 pounds pressure by gauge. The safety valves will be set to blow at 10 pounds above the mean pressure carried, and care will be taken to prevent a blow during trial.

The water delivered to the boilers will be drawn from the city mains into a receiving tank set on a platform scale. From this it will be drawn into a supplemental tank set below. From the supplemental tank the water will be delivered to an independent boiler feeder connected with check valve of boilers. The steam required to drive the boiler feeder will be taken from a duplicate battery of boilers set alongside those furnishing steam to the engine under trial. The water fed to boilers will be determined in weight while in the receiving tank.

The quality of steam will be taken in the pipe leading from the main pipe to the engine by a continuous calori-

meter with entry pipe set opposite to the direction of flow in the center of steam pipe.

The condensing water will be obtained from the Miami Canal in the rear of Exposition buildings by natural lift, and the overflow from hot well will be returned to the canal by natural flow.

The overflow from the hot well will be measured in transit to the canal to determine the weight of water expended in effecting the vacuum. The water weighed to the boilers (assuming saturated steam) will represent the condensation by work, and condensing water; and the difference between the weight of water measured and the quantity weighed to the boilers will represent the weight of condensing water required to produce observed vacuum in the condenser.

The steam pressure in the pipe leading to the engine will be fixed at 90 pounds, and will be taken by gauge with entry pipe set opposite to the direction of flow in center steam pipe.

The vacuum will be taken by spring gauge in the condenser.

The temperature of overflow will be taken in the hot well.

The diagrams from the cylinder will be taken with Thompson indicators. The diagram will be read for initial pressure, for cut off, for pressure at cut off, for terminal pressure, for release, for counter pressure, for exhaust closure, for compression pressure, and for mean effective pressure From the diagram will be deduced the maintenance of steam pressure to cut off, the relation of actual to theoretic expansion, the relation of actual to calculated ratio of expansion, the steam accounted for, and the relation of vacuum in the condenser to vacuum in the cylinder. *But the economy of engine will be calculated from the known weight of steam delivered to the pipe.*

The revolutions of engine will be taken by continuous counter.

The temperature of injection and water in hot well will be taken with Green thermometers.

An aneroid barometer will be used.

The resistance will be obtained by rotary pumps driven by belts from test trial line shaft. The loads will be regulated by throttling the discharge orifices.

The indicated load for engine non-condensing will be fixed at 160 horse power, or less; and the indicated load for engine condensing will be fixed at 220 horse power, or less. The loads condensing and non-condensing will be alike for all engines, and maintained as uniformly as possible for each trial.

The time will be taken from a chronometer clock.

The signals for observations will be rung on the gong regularly every 15 minutes—two taps of the gong will call the attention of assistants to an approaching observation, and one tap following will indicate the termination of a 15 minute interval.

Previous to the trial all pipe connections from all but the engine under trial will be closed by blank flanges.

The duration of trials will be fixed at 10 hours for engine condensing, and at 10 hours for engine non-condensing. Previous to the commencement of each trial, condensing and non-condensing, the boilers will be steamed up to the pressure necessary to maintain 90 pounds by gauge in the pipe at engine under trial; and the height of water in the boilers brought to working gauge point; all water supplied to the boilers thereafter will be weighed and charged to the engine, subject to correction by calorimeter data. At close of each trial the water level and steam pressure will coincide with conditions at commencement of trial.

During condensing and non-condensing trials the engine will work with stop valve set entirely open.

At close of second trial on each engine the main belt will be removed, and engine operated for 30 minutes without load other than its own friction, for friction diagrams. The counter will be read regularly every minute during this trial.

The economy of engine will be deduced from the net weight of steam supplied during the trial; no notice will be taken of the coal actually burned in producing the steam, the boilers being worked simply to supply the required quantity of steam in best thermal condition and at uniform or constant pressure; and the cost of the power in coal per indicated and per gross load, horse power per hour, will be stated upon an evaporation equivalent to 10 pounds of steam per pound of coal.

The steam gauges, vacuum gauges, engine counters, and steam engine indicators used in the trials will be furnished by the American Steam Gauge Company, Boston, Mass.

JOHN W. HILL, *Chief of Experts.*

Cincinnati, Ohio, January 7, 1880.

RAPID STEAM COMMUNICATION WITH AUSTRALIA.

THE arrival of the Orient at Adelaide has been telegraphed, the passage from Plymouth, including all stoppages, having been made in 37 days and 22 hours. The stay at St. Vincent occupied 27 hours, that at the Cape (particulars of which are not yet known), in all probability, would have not been less than 24 hours, the passage thus being made in rather under 36 days—steaming time. The fastest passages to Australia previously recorded are that of the Lusitania, from Plymouth to Melbourne direct in about 40½ days, and that of the Cuzco, from Plymouth to Adelaide, in 40 days 8 hours. The Orient and Cuzco were both built and engined by Messrs. John Elder & Co., of Govan; the Lusitania by Messrs. Laird Bros., of Birkenhead. The Orient is commanded by Captain Studdert, late of the Pacific Company's service. The distance from Plymouth to Adelaide, by the Cape, being about 12,000 nautical miles, the Orient must have maintained an average speed for the whole voyage of over 14 knots per hour, a performance, having regard to the great distance, unequaled in the annals of steam navigation.

An engraving and description of this great ship was published in our SUPPLEMENT, No. 204.

POROSITY OF CAST IRON.

CAST iron is said to be permeable to certain gases at high temperatures, and, according to L. Cailletet,* to hydrogen gas even when cold. Whether the gases pass through the pores, or through invisible air holes so minute that they may be classed as pores, is immaterial so far as concerns the furnace maker. It is sufficient to know that microscopic air holes are so liable to be present in the castings that the material has been condemned as unsafe and unsuitable for gas holders, compressed-air tubes, and all places where a gas pressure has to be resisted.

* "L. Cailletet überzeugte sich dass das Eisen, nicht nur wie Deville und Troost nachgewiesen, im stark erhitzten Zustande sondern auch bei gewöhnlichen Temperatur von Wasserstoffgas durchdrungen werde." (Wagner's Jahresbericht, vol. xiv., p. 54.)

In order to test the degree of this permeability under varying pressures, the writer had cast six cylindrical boxes from some of the softer iron used by a foundry man in making furnace and stove castings.

The boxes appeared to be perfect in every particular.

The top or mouth of each piece was threaded after casting so as to receive the end of a piece of gas pipe two meters long threaded to correspond, making with cement an air-tight joint. (Gas piping was formerly frequently made of cast iron, but its permeability to gas under pressure was too great, and it was abandoned in favor of wrought iron.) Clean mercury was then poured into the gas pipe, and the pressure in atmospheres on the casting was known by the height of the mercury column. It was found that under pressures varying from one to three atmospheres, the first three of the six castings tested allowed the mercury to pass through the pores or air holes in minute jets, projecting it, when the pressure was greatest, a distance of more than a meter from the vessel. Yet the feeblest pressure was sufficient to cause it to escape from the largest openings. The other three castings resisted the test. A greater pressure than three atmospheres could not be applied with the materials at command. The mercury became much dirtied, after the first three experiments, by impurities in the gas pipe and castings, so that it is possible that the amalgam thereby formed filled the pores in the last three castings and itself prevented the passage of the pure mercury.

This experiment was suggested by the experience of Professor Wolcott Gibbs, of Harvard University, from whom I have the following: He was filling a cast iron pot with mercury, and had poured into it about fifty kilogrammes of the metal, when it was observed suddenly to shoot out in fine streams in all directions through the pores of the vessel. Professor Gibbs described the iron which he used to be perfect so far as the eye could detect. The boxes in which mercury is put up for the market have to be made of wrought iron

The six castings tested as above described were fifteen centimeters long each, and nearly two centimeters in diameter. The metal was two millimeters thick at the threaded end, under the shoulder, and about 5 millimeters thick at the other end. The object of this gradation of thickness was to discover what effect the thickness of the coating had upon its permeability. It happened that the mercury escaped in all cases at points near the middle of the cylinders, where the metal was of medium thickness. But inasmuch as it did not flow from all parts of the castings with equal freedom, but rather from particular localities in each, it would appear that it could hardly have passed through *pores*, as the term is commonly accepted, but rather through minute accidental pin-holes between the granules or crystals of the materials not to be avoided in casting. In this case iron of a hard, close texture would be open to these imperfections as well as soft iron, though not to so great a degree on account of the smaller size of the crystals. These openings may be partially closed by filing the surface of the casting. A file was passed over one of the castings tested while the mercury was escaping under the pressure. A number of the jets were obliterated, only the stronger ones remaining. For this reason samples to be tested should not be turned or filed, but subjected to the pressure in the rough state as they come from the foundry. It is also in this state that they appear in furnaces, for the sake of which the tests are made.

Hammering is still more effective than filing, and in wrought iron the pores and air-holes are completely closed.

Thus every part, as large as the small samples tested, of every casting used in a furnace, is liable to come out riddled, like them, with minute holes invisible to the eye, yet large enough to allow of the escape of gas under pressure. This outward pressure exists more or less frequently in every hot-air furnace now known. In the ordinary dome furnace it is constant in ordinary use, as previously said. Furnace men will differ in regard to this and will say that it is impossible, thinking that a powerful upward chimney draught would overcome any slight upward tendency given by the height of the dome above the lower opening into the smoke flue.

Others will be as positive the other way. But the practical furnace man is unfortunately not the authority to consult on these matters. He is commonly ignorant of the scientific principles which should govern the construction or regulate the use of a furnace, and generally unwilling to see the virtue of any arrangement not found in his own.—*American Architect.*

ON THE HEATING POWER OF COAL GAS.

By DR. WM. WALLACE, Coal Examiner, City of Glasgow.

THE very extensive employment of coal gas for heating purposes, and especially for cooking, gives an interest to the question of whether the heating power varies like the illuminating power, and if so, to what extent in the gas used in different towns. As regards illuminating power, we know that it varies exceedingly. In Aberdeen and Edinburgh it is 30 candles for about 5 cubic feet per hour; in Glasgow, Paisley, and Greenock, about 26 or 27; in Liverpool, Manchester, and Carlisle, about 20; in London and Dublin, 16; in Birmingham and many other English towns, 14; and in some as low as 12. But as regards heating power, we have no definite information, although there is a general belief that a rich gas has a greater calorific effect than one of poorer quality.

My attention having been directed to the subject by a correspondent, I caused a small apparatus to be made, in order, when opportunity offered, to test the matter practically. It is of very simple construction, consisting of a cylindrical tin plate vessel, 8 inches in diameter and 6 inches high, with a cylindrical opening in the center 1½ inches in diameter, through which the whole of the products of combustion pass. Below is a brass tube bent into a circle 5 inches in diameter, and pierced in 34 small holes, from which the gas burns with flames about ⅝ inch high. This tube is placed 1 inch from the bottom of the vessel, and is surrounded by an outer case having a sufficient number of small holes for the admission of air. On the top of the vessel there are two openings, in one of which a delicate thermometer is placed, while the other is provided with an open glass tube.

The opportunity of using the apparatus occurred recently when I had occasion to test on the same day three samples of coal, which gave gas of 33, 26, and 15 candle power, respectively. Each experiment occupied as nearly as possible 30 minutes, and consisting in raising one gallon of water from 60° to 160° Fahr., and measuring the gas consumed in the operation. The system is by no means a perfect one, but the results are strictly comparative. These are arranged in the following table:

Illuminating Power of Gas in Standard Candles.	Durability of 1 Cub. Ft. by Flame Five Inches High.	Specific Gravity, Air equals 1,000.	Comparative Value for Lighting.	Gas Consumed in Heating Experiments.	Heat Units, Fahr., for 1 Cubic Foot.	Comparative Value for Heating.
	Min. Sec.		s. d.	Cubic Ft.		s. d.
33·07	64 45	574	4 10	1·916	522	4 5
26·24	54 40	525	3 10	2·200	455	3 10
14·75	39 35	442	2 2	2·888	347	2 11¼

The heat unit represents the number of pounds of water heated 1° Fahr. by the combustion of one cubic foot of gas. I have taken Glasgow gas of 26 candles at 3s. 10d. per 1,000 cubic feet as the standard of value, and it will be seen at a glance that while the heating value rises and falls with the lighting value, the amount of difference is by no means so great in the latter as in the former.

Having made these simple but instructive experiments, I naturally wished to compare the results with the theoretical heating values obtained by calculation from the consumption of the gases. Unfortunately, I had no apparatus at the gas works where the experiments were made for analyzing the gases; and the best I have been able to do is to make the calculations from two analyses by the late Dr. Letheby, one of 12-candle gas, and the other of London cannel gas, the illuminating power of which is not stated, but which may be assumed to be somewhere between 22 and 23 candles. The analyses are given only (as is usual with gaseous mixtures) by volume, but for convenience I calculated the composition by weight:

	Common Gas. Twelve Candles. Volume.	Common Gas. Twelve Candles. Weight.	Cannel Gas. Twenty-two Candles. Volume.	Cannel Gas. Twenty-two Candles. Weight.
Olefiant gas, etc. (C_2H_4)	3·8	9·5	13·0	24·9
Marsh gas (CH_4)	39·5	56·5	50·0	54·8
Hydrogen	46·0	8·2	27·7	3·8
Carbonic oxide	7·5	18·7	6·8	13·0
Carbonic acid	0·6	2·4	0·1	0·3
Nitrogen	0·6	1·5	0·4	0·8
Aqueous vapor	2·0	3·2	2·0	2·4
	100·0	100·0	100·0	100·0

	Common Gas.	Cannel Gas.
Specific gravity (calculated)	387	506
Weight of a cubic foot in pounds	0·0296	0·0387
Calorific power (Cent.)	11,790	11,754
Calorific power (Fahr.) pounds of water heated one degree by the combustion of one lb. of the gas.	21,222	21,157
Heat units for 1 cubic foot (Cent.)	345	455
Heat units for 1 cubic foot (Fahr.)	621	819
Pounds of boiling water evaporated by 1,000 cubic feet of gas.	639	842

We see from this tabular statement that, while the heating power of the two gases is almost identical, weight for weight, the practical result, when we take the same measure of gas, is very different, the cannel gas being much heavier than the common gas. I calculate that in my practical comparative test I have realized about 55 per cent. of the theoretical heating power, which is pretty nearly the proportion of effective heat by the combustion of coal in a well constructed boiler.

The question naturally suggests itself, What is the comparative cost of heating by gas and coal? The calculation is a simple one. The theoretical heating power of ordinary soft coal may be taken at 12—that is to say, the number of pounds of boiling water evaporated by one pound, equal to 29,120 pounds for a ton of coal, value, say, 11s. 6d., being the price of 3,000 cubic feet of cannel gas, the heating power of which is, say, 2,500. The gas, therefore, costs 11½ times as much as the equivalent quantity of coal, or, in round numbers, a pennyworth of coal gives as much heat as a shilling's worth of gas. When, however, we consider the handiness, the cleanliness, and the convenience of gas, it is not surprising that it is extensively employed as a source of heat, as an illustration of which I may state that in my own laboratory from 250,000 to 300,000 cubic feet are consumed annually, almost the whole of which is burned for the production of heat.

An interesting discussion followed, the speakers being Messrs. John Jex Long, W. P. Buchan, William Foulis, D. M. Nelson, and William Key. The last named thought that Dr. Wallace had not obtained the full practical value out of the gas, seeing that he had not burned it on the Bunsen principle, to which Dr. Wallace replied that it was a mistake to suppose that the adoption of that principle was a necessity under all circumstances. In his case there would have been no advantage in adopting it, as he used small blue flames which were totally devoid of smoke, and which, therefore, gave the most perfect combustion.—*Jour. of Gas Lighting.*

COMPARATIVE VALUES OF GAS AND COAL—THE FUEL OF THE FUTURE—CURIOUS SPECULATIONS ABOUT THE WASTES OF COAL.

By GEORGE S. DWIGHT.

FUEL is a prime necessary to all classes of humanity, whether savage or refined, and in its aggregate annual consumption represents a greater quantity in weight than any other single article of man's use. When it is remembered that this use, from the nature of the case, is an absolute destruction of material, involving a constant reduction of supplies having known limits, it becomes a most startling fact that in no other department is the waste so appalling and the useful result derived so small. In other words, of the heating power really contained in the material, by far the smaller proportion is utilized, while the greater is lost.

And it is a humiliating fact that, in this extravagance, the men of civilization are not much behind their Esquimau brethren, their greater comfort derived from the hearth being rather the result of the larger expenditure of better fuel,

with more favorable surroundings, than because of its more economical use. This enormous wastage, though imperfectly understood even by most men of science, is scarcely thought of by the great mass of people to whom it is, nevertheless, a matter of the utmost consequence—a matter in which are connected together cost, convenience, comfort, labor, and health. To illustrate the first question, of cost, that being the argument which most readily appeals to our busy race, a few striking facts may be stated regarding the fuel use of the city of London; for it is quite fair to judge of the art of combustion by its practice in one of the most refined centers of civilization.

There are (8,000,000) eight millions of tons of coal, independent of other fuel materials, annually consumed in that great metropolis. The mining of this immense mass of mineral involves a loss in dust or slack, of one fourth as much more, say (2,000,000) two millions of tons, which, not having heretofore been considered commercially valuable, is accumulated in mountainous heaps at the mines. The handling of this latter, however, constitutes an item of cost which must be added to the price of that sent to market; for, in this century, the hand of labor, like that of Midas, changes values by its mere touch.

The transport to market of such a vast weight occasions an aggregate of toil, wear, tear, and loss, which further swells the cost before delivery to the consumer; but, for present purposes, it will suffice to consider the waste from the time it is in his possession. We shall find that this first cost, excessive though it be, is yet to be wonderfully augmented by secondary expenses; for after it has been deposited in the cellar, it must all be rehandled, remined, as it were, and carried up stairs and to the grate.

This outlay is not one of money simply, but of labor, and as, strictly considered, physical exertion is equivalent to an expenditure of heat, we may well speculate upon the units employed in moving (50,000,000) fifty millions of pounds of coal, and (10,000,000) ten millions of pounds of ashes, each day in the year, exclusive of collateral exertions incident to the maintenance of fires and of the energy of those moral heat-units wasted over refractory and exasperating grates and stoves. And yet this is but the beginning of loss; for, by the most liberal allowance, after all these expenditures are made, only about (10) ten per cent. of the heating power of the material is obtained.

To realize the thermal value of (800,000) eight hundred thousand tons (8,000,000) eight millions are burned!

Not to enter upon a tedious analysis of the causes of this tremendous loss, it may be simply explained by the statement that it results from the imperfect combustion inevitable to the burning of a mineral form of carbon in atmospheric air.

A large amount of heat is expended in converting the coal to gases; for it is only these latter, and not the coal itself as such, that burns; and in this process of conversion and the subsequent combustion, the composition of the air is very unfavorable to a good result. Exactly the chemical mixture for sustaining life, it is but poorly adapted to combustion, because its oxygen, the only combustible element in it, constitutes but one-fifth of its volume, while the nitrogen representing four-fifths, is not only useless in combustion, but retards it and absorbs a large proportion of the heat of the fire. If precisely the right theoretical minimum of air, (11·61) eleven and sixty-one hundredth pounds, is used in the burning of one pound of good clean coal, the temperature of the fire is 4,889° Fahr. If (24) twenty-four pounds of air are admitted to the furnace, the temperature will be reduced to about 2,450°. And yet, despite this serious depreciative effect of an excess of air, Dr. C. W. Siemens states that even in metallurgical operations, under skillful superintendence, the quantity of air used is (300) three hundred cubic feet, equal to (24) twenty-four pounds to each one pound of coal; and to illustrate the vastness of such a volume in many cases, instances his own establishment at Gateshead, where, he says, are "seven furnaces, each of which uses about one ton of fuel per day, in all seven tons; therefore 7×24=168 tons of air required. Again, a pound of coal requires about (300) three hundred cubic feet of air. If we imagine the 168 tons of air made into a long stream of one square foot in area, the total length will be (21,381) twenty-one thousand three hundred and eighty-one miles." Of this vast stream (16,891) sixteen thousand eight hundred and ninety-one miles are useless nitrogen, passing into the furnace cold and out of it hot!

If the excessive use of air is unavoidable, even in the most perfect furnaces, under scientific supervision, and occasions so extensive a loss, it may be inferred how great a waste of heat from this single cause must occur in domestic grates and chimneys imperfectly constructed, and under the ignorant management of servants. On the other hand, if too little air is used, a partial conversion ensues, and a large proportion of the most valuable combustible gases drift out of the fire-place unconsumed. Thus, between the two difficulties it happens that, from the chimneys of our homes, far more heat is going to waste than is utilized within the dwellings. If we consider that, by moderate estimate (400,000) four hundred thousand tons of smoke, soot, and dust, and (120,000) one hundred and twenty thousand tons of sulphur, annually thus pass into the atmosphere of London, we cannot be surprised that its skies are darkened and its air heavy. It is probable that an analysis upon one of its days of black fog would show the air to represent in fair proportion the elements requisite to the production of the best combustible gases, namely, carbon, oxygen, and hydrogen. But for the limitless energies of Providence and the corrective operations of nature, man would soon poison the atmosphere on which he is dependent.

It must be admitted, on the above facts, that the art of combustion, instead of having attained the refined development of any other art, is the most conspicuous reproach upon the civilization of the age. The management of crude fuels is no more successful than the attempt would be to individually manufacture, in our homes, our garments and food from the raw materials of nature. Strictly, it involves more serious difficulties than those processes, and the day is at hand when it will be wondered that a refined and progressive society could have so long tolerated such a rude method.

But how may the reformation of so glaring an evil be effected, and both the primary and secondary loss, already explained, be reduced?

Within a few years a system has been steadily developed by which coal may be converted to the gaseous condition, in an atmosphere of steam instead of air, by which the bad influence of nitrogen is avoided, because the water, unlike the air, is composed entirely of combustible gases—oxygen and hydrogen. As explained before, a large amount of heat is necessary for the gasification of the coal, and this expenditure cannot be entirely avoided, because a high temperature must be maintained in the furnace for the preparation of the steam; but by a scientific and economical application of the heat, it is largely reduced by the new system. The product is a gaseous mixture of purely combustible character, in place of the largely non-combustible gas generated by the ordinary use of coal. The economic fact about the new gas is, that it represents a much larger *available* heating power than can possibly be obtained from the coal, by any other known process.

Of course, the gas cannot contain as much heat energy as the coal from which it was derived possessed theoretically, because, as has been shown, the very act of conversion from the solid to the gaseous state necessarily involves the expenditure of a portion of its heat; but that there is a very wide difference between theoretic and practical values has, it is hoped, been somewhat demonstrated by the foregoing statements. It is simply claimed for the Strong system that, after sustaining this loss, which, in varying degrees, is inevitable to all methods of combustion, it has a larger caloric value left, and in a more perfect form for thorough utilization than is obtainable by any other method at present known to science; and this claim both experiment and practice, on a large scale, most fully substantiate. Take a technical illustration of this: If one pound of the best coal is burned under the most perfect conditions attainable in the laboratory, it develops heat sufficient to raise the temperature of (13,000) thirteen thousand pounds of water (1°) one degree Fahr. Hence its calorific power is said to be equal to (13,000) thirteen thousand units of heat. But this valuation is the highest theoretical one, and nothing approaching it can be realized in practical operations. As already stated, one-tenth of this would be a liberal estimate for the proportion utilized in general domestic uses. That would be (1,300) thirteen hundred units.

If the one pound of coal is converted by the Strong system, the resulting gas possesses a theoretic heating power, by the same standard of determination, of (9,049) nine thousand and forty nine units. The difference of (3,951) three thousand nine hundred and fifty-one units has been expended in the gasification of the coal. This loss, amounting to about one-third of the whole, is the one already explained as inseparable from conversion, and though it seems a heavy item, practically ends the waste, because the gas thus obtained can now be burnt so completely and economically that further loss in its combustion need not exceed (10) ten per cent. Allowing for this loss, we shall still have as the heating power *actually* realized in practice (8,141) eight thousand one hundred and forty-one heat units, as against (1,300) thirteen hundred units, when the crude coal was used. In the one case, but (10) ten per cent., and in the other (62) sixty-two per cent. of the maximum calorific power of the fuel is obtained. Let us now take a very simple practical confirmation of this statement. During recent investigations of the new system, committees of scientific and practical gentlemen have visited the works, and on repeated occasions substantial dinners, comprising meat, oysters, vegetables, bread, pastry, and coffee, for a party of six, have been cooked by the consumption of (30) thirty cubic feet of gas. To produce that volume of gas required (1½) one and one-fifth pounds of coal. Would it be possible to prepare such a meal with such a weight of crude fuel? Would any London cook undertake it with less than ten times the coal?

The new system makes another important reduction in first cost by utilizing various forms of fuel at present considered inferior, and which are, therefore, cheap; as, for instance, the dust-coal, which, as mentioned, has hitherto accumulated in vast waste heaps at the mines, and which, by Mr. Strong's method, is shown to be, in some respects, superior to the lump, now exclusively sent to market, partly because its more easy conversion still further reduces that item of cost.

Recent operations in America and Europe prove that all grades of fuel are not only available, from pure anthracite to common peat, but yield the same quality of gas in all cases. Guided by the experience of all industrial arts, which shows that systematic manufacture on a large scale, conducted by intelligent workmen, with ample facilities, tends both to the improvement of the product and the reduction of its cost, it is proposed that the fuel shall be converted to gas at suitable central works, instead of as now, in each man's house, and delivered to the consumer by means of pipes, as is now done with illuminating gas. This wholesale manufacture will not only, in connection with the other items of saving mentioned, greatly reduce the first cost, but will work a wonderful change in the secondary cost, now so excessive; because, in a gaseous form, the fuel becomes capable of self-transportation and requires no more the expensive touch of human hands, except for its mere control.

Instead, now, of the repeated handling of (10,000,000) ten millions of tons of dirty material in the shape of coal and ashes, the labor is at once reduced to the turning of a valve to regulate supply. The combustion of the gas is so perfect that its flame, resembling that of alcohol in cleanliness, though possessing three times its intensity, leaves no soot or smoke upon the pot to justify the kettle in calling it black, thereby relieving the cook from much untidy work. What the real comfort and convenience of gas consumption in domestic use is, can only be fully appreciated by those who have tried it, and such are unwilling to return to the old plan. So great is it that the skillful cooks of Paris find the use, even of the comparatively costly illuminating gas, so advantageous that the company there reports the sale for 1878, for purposes *other* than illumination, of (1,800,000,000) eighteen hundred millions of cubic feet! All the food for the hospitals is thus prepared; and many other cities the world over are taking the hint, and increasing their consumption of gas for such purposes; although, for general fuel uses, the present illuminating gas is too costly.

Not so, however, with the water gas by Mr. Strong's system. It is not, like the other, dependent upon a special quality of coal, but may be derived from any fuels, and generated from these upon strictly scientific and economical principles. It is able everywhere to compete successfully with the crude material from which it is obtained.

There are also collateral advantages, scarcely less important than cost. It would remove from our houses the pernicious method of burning coal, with its excessive labor, uncleanliness, and risks, not the least of which latter is a sanitary one resulting from the diffusion into our domestic atmosphere of baleful gases representing at once both waste and danger. If these are powerful enough to exert a corrosive influence on silver ware, paintings, and books, what damage may they not inflict on the delicate tissues of the human body?

Should London adopt the "fuel of the future," as it is already called, it would, besides securing other immeasurable benefits, improve the health and happiness of its inhabitants by admitting into their streets and dwellings more of the sunshine and the blue sky; for the smoke and sulphur would be relics of a semi-barbarous past. Although, for illustration, only domestic uses have been instanced in this article, because these represent at once the largest and most wasteful employment of fuels, the gas here described is equally available and economical for metallurgical and all other industrial arts.

It is also specially adapted to the generation of power by means of modern gas engines. It is definitely settled, by extended practice, that motors of this description, besides having the advantage of safety, as compared with steam, are positively cheaper in money cost, even at the high prices now charged for illuminating gas. Such engines are already in use in Paris to the extent of over five thousand horse-power. If, then, a cheap and efficient gas like that produced by the Strong process were distributed to every man's dwelling and workshop, how wonderfully would the minor industries of the race, which in the aggregate represent the great bulk of its work, be at once stimulated and simplified! At a selling price of 50 cents per thousand feet (a price at which it would pay a large profit to the producer), one horse-power would cost the artisan two cents per hour. Here would seem to be a promise to the mechanic and small manufacturer of that relief against the overwhelming advantage now possessed by capital and costly machinery, to which an eminent philosopher of Germany (Prof. Reuleaux) has recently claimed they are entitled, and must have, to prevent the increase of commercial oppression and socialistic antagonisms.

The water gas is also admirably adapted to purposes of illumination, by intermixture with light-giving hydrocarbons, which may be accomplished in several ways and by the employment of a great variety of materials, at an important saving, as compared with the old method. The superiority of the light so produced has been amply demonstrated in the United States, where the system is in extensive and successful operation in many important towns and cities. Its general adoption is already foreshadowed. Works are now building in that country for the distribution of both the non-luminous and the illuminating gases, so that domestic heat, light, and power may be sent out to the citizens. The erection of such works marks an era in this important art of civilization. The purposes of this article being more especially to treat of gas as a *fuel*, the departments of power and light are briefly mentioned as collaterals; and yet that these are only interchangeable phases of one subject, to which they are inseparably related, may be strikingly illustrated by mentioning, in conclusion, that the nightly lighting of London involves the expenditure of heat energy equivalent to (2,112,292) two million one hundred and twelve thousand two hundred and ninety-two horse-power.

It is hardly utopian to claim that, in comparison with the gigantic labor, loss, and disadvantage generally in the present use of crude fuel, the remedy is simple and easy, and to predict that the intelligence of the age will ere long demand its prompt and universal application.—*Engineering and Mining Journal.*

WOOD PAVING.

AMONG the largest items of consumption of the coarser grades of lumber and timber, the matter of paving blocks is of the greatest importance. There is scarcely a city or town of any importance in the country but boasts of from one to a hundred miles of wooden block roadway, and we venture to say that the use of wood for this purpose has, all things considered, given as good or better satisfaction than any other style of paving. The objections to it have been largely from its tendency to wear in holes, necessitating frequent repairs after the second or third year. To obviate this trouble, various plans have been tried, but the experiments in the city of London, England, seem the most conclusive and satisfactory of any which have come under our notice.

The city engineer in his report for 1878 says that the manner in which the roads are laid comprises a foundation of macadam or concrete to a depth of six or eight inches. This is solidified with heavy rollers, packing all the interstices so that there is little or no chance for a settling of any part. Some of the experiments have included an asphalt mixture on top of the macadam, rendering the surface strong and impenetrable to water. Blocks of the usual size are then placed in the usual manner on this foundation, and it is safe to say that they will wear for years and until worn or rotted out without the annoyance of holes, such as are inherent in the temporary board or sand foundation. The foundation once laid will wear for ages, and the renewing of the blocks is a matter of slight expense. Pavements laid with such solid foundations will not ordinarily cost more than double what the present light foundations do, and in a run of 15 years will prove the cheapest.

In London the wood and asphalt pavements are laid by a company whose contract includes keeping them in repair for 15 years for 25 cents a square yard per annum, after the second year. Of the comparative merits of wood, asphalt, and granite pavements, the engineer reports that during the working days of March and April, or between eight o'clock A.M. and eight P.M., the number of horses passing over the different portions in our tests were as follows: Over the wooden pavements, 32,000; over the asphalt, 23,000; over the granite, 14,000. The traffic was divided into vehicles drawn by one horse, 71 per cent.; by two horses, 26 per cent.; the remaining three per cent. embracing those drawn by three or four horses. The number of horses falling down during the 50 days of test was 2,327, of which 542 fell on the wood, 719 on the granite, and 1,066 on the asphalt. Without going into all the details of this interesting report, we may say that the strain upon the horses was calculated upon its effect upon endurance, and it was estimated that with the same expenditure of force a horse could travel 132 miles on granite, 191 miles on asphalt, and 415 miles on wood. In wear and tear of vehicles, horse-flesh, and shoeing, the saving in the life of horses is as five to two in favor of wood, and in repairs and shoeing, as two to one; in other words, it costs just one-half as much to keep up repairs upon shoes and vehicles upon wooden pavements as it did upon the stone and asphalt, and three horses will last as long traveling upon wood as would five upon the harder surfaces.

The secret of a good wood block pavement is in the formation of a solid foundation from which the water can quickly drain after a rainfall. Preferably the top should be water-tight and crowning in the center; the blocks should be of sound live timber, all of one variety of pine or other wood, in pines of all kinds, free from sap, and the interstices well filled with gravel, well cemented. For a permanent street all sewer, gas, and water pipes should be laid before the pavement is commenced, so as to obviate the necessity of disturbing the foundation after it has once been formed.

Cedar blocks six to eight inches in length—the latter is worth more for wear than the increased cost—are the great favorite, in such localities as can obtain them, in competition with pine, and when well graveled in the first place and treated to a second coat of coarse gravel after having had a year or two of wear, in order to again restore the stony surface gained by the tramping and rolling in of the stone by the horses and vehicles which first pass over them, and which surface will measurably wear off in a couple of years, this wood may reasonably be expected to wear out before any material depreciation from decay will be discoverable.—*N. W. Lumberman.*

NEW COLORING MATTERS.

P. GREIFF.

IF one part of chloranil is allowed to act upon two parts of dimethylanilin a deep blue coloration is observed, even in the cold. On heating to 50° the reaction is complete, and a bronze-colored melt is obtained, which is insoluble in water, but gives up to alcohol and acetic acid a deep violet blue color of great purity. If instead of dimethylanilin, methyldiphenylamin is employed, a blue color is obtained, more beautiful than any yet known. The reactions are very complete and the yield is high.

SEPARATION OF FATS AND SOAPS.

JUSTUS WOLFF.

THE mixture of soap and fat is comminuted as far as possible, mixed with from 10 to 20 parts of purified aniline, and digested in the water bath, stirring and crushing continually for half to three-quarters of an hour. The solution is filtered when cold, and the residue is several times treated with aniline. In the residue is found all the soap, whilst the resins and fats are in the solutions. These are poured together, mixed with hydrochloric acid and with 3 or 4 parts of water, and when cold shaken with ether. The ethereal solution on evaporation leaves the unsaponified fats and resins. The aniline must be free from benzol and nitro-benzol.—*Zeitsch. Anal. Chemie.*

STRIPPING COLLODION TRANSFERS.

SINCE the collodion transfer process has become such a popular one for the production of enlargements, we have had on many occasions to answer queries in our correspondence column as to the cause of blisters in the transferred print, or the reason why in stripping the picture some parts show a greater affinity for the glass plate than they do for the paper that is to be its final support, although there is apparently no reason why the collodion should not leave the plate freely. We have also heard complaints that when the transfer has been effected the film adheres so loosely to the paper that it comes off when the color is applied, or that it can be peeled off in flakes by the insertion of the point of a penknife between the film and paper. These troubles invariably arise from a want of knowledge, on the part of the operator, of the properties of the coating on the paper.

The operation of transferring a collodion picture is analogous to that of transferring a carbon print, and the means adopted are precisely similar. At one time the paper that supported the picture was prepared by simply floating Saxe or Rive paper on a plain solution of gelatine and drying it. When required for use a sheet was soaked in cold water and then brought in contact with the picture under water, so as to avoid air bubbles. When the whole was dry the separation was completed. The disadvantage of this mode of procedure is that the pictures take an unduly long time to dry, on account of the large quantity of water absorbed by the gelatine before it becomes sufficiently soft for use, and also that the picture was held to the paper by a substance thought by many to be subject to hygrometric influences. For these reasons it has been the custom of late years to add to the gelatine solution with which the paper is prepared a certain proportion of chrome alum, so that the coating once dry becomes practically insoluble; yet, when treated with warm water, it becomes sufficiently adhesive to secure the film in such a manner that no fear need be entertained of its ever again being separated.

A good formula for making such a paper, and one that is well adapted for collodion transfers, is to soak three ounces of good colorless gelatine in a quart of cold water until it has swelled and become quite soft, then heating to about 120°. When the gelatine has dissolved, *about* eight grains of chrome alum dissolved in a couple of ounces of water are added, the solution being briskly stirred while the addition is being made. It is then transferred to a flat dish, placed in a water bath, sustained at a temperature of 110°. Upon this Saxe, Rive, or other fine paper is floated, and afterwards dried.

In the above formula we have not given a definite quantity for the most important item, namely, the chrome alum, nor is it possible to do so with any idea of certainty, inasmuch as it will vary with every kind of gelatine used, some requiring more and some less, so that the exact amount can only be arrived at by direct experiment. The larger the proportion of alum added the more insoluble the coating will be when dry, and, consequently, the hotter the water will have to be to bring it into proper condition for use. The proportions given above will generally be found to work well if the sample of gelatine used be that known as "Nelson's No. 1 photographic." In practice, however, most operators prefer to use the double transfer paper supplied for carbon printing, as they are thereby saved the trouble of preparation, and it also proves much cheaper than the home made.

Now, double transfer paper is simply paper coated with a preparation such as we have described, to which is added a white or colored pigment; this, in a great measure, hides the texture of the paper. We have recently seen some paper that appeared to have been enameled after the manner of the old Brinkhoff paper before the gelatinous coating was applied. By this means the fiber of the paper was completely hidden, which rendered it specially suitable for the production of fine work. Paper prepared in the manner we have directed, although generally described as being insoluble, will still absorb water and swell up, provided the water be heated to 90° or 100°, and will then acquire a slimy feel very similar to that of wash leather that has for a long time been steeped in water. But if the soaking of the paper be long continued, and the water hot enough, in time the whole of the coating will be dissolved off. The proper condition for our present purpose is secured when the coating has become *slimy* or decidedly gelatinous. If it be allowed to remain in the water long after this stage is reached then there is the danger of the whole being removed, so that no adhesive material is left to cement the collodion film to the paper. Few failures, however, result from this cause; it is rather in the reverse direction that they arise, namely, from the coating not being rendered soft enough.

It is well known to carbon operators that all gelatine films containing chromic salts become more insoluble the longer they are kept, so that a transfer paper that may only require a temperature of 90° when freshly prepared will perhaps require as much as 110° to bring it into a proper condition for transferring after it has been kept for three months, and after six months' keeping a long immersion in water as hot as 130° will sometimes be necessary to get it into a good state for use. Eventually it will become so leathery and insoluble that long soaking, even in boiling water, will fail to render it serviceable, and it is the want of knowledge of this property that has led to many failures in transferring collodion pictures.

It is the practice, we believe, of some who supply transfer paper to note on each roll or parcel the temperature the water should be to render it fit for use. From what we have said it will be seen that, even when this is done, it will only apply when the material is freshly prepared, and that allowance must always be made by increasing the temperature as it becomes more insoluble by keeping. It has been pointed out by Dr. Eder and others that both heat and moisture have a marked effect in hastening the insolubility of gelatinous compounds when in combination with chromium salts, and we have reason to believe that transfer paper kept in a warm and damp atmosphere acquires insolubility much sooner than if preserved under opposite conditions.

We will here add a hint as to the method of applying the transfer paper. Having been cut into sheets a little less than glass plates, it is then soaked in warm water until the proper condition is arrived at. The collodion film is then flooded with cold water, and the paper gently lowered upon it, avoiding air bubbles, the excess of water being expelled by the aid of a squeegee. The squeegee should not be so hard and firm as those in use by carbon printers. The India rubber tongue should be both broader and softer, which will give more elasticity and consequently less pressure. If too great a force be applied, and the gelatine coating very soft, there is a danger, when the collodion is of an extremely porous character, of its being forced through the film on to the glass, and thereby causing adhesion to it.—*British Journal of Photography.*

PHOTOGRAPHING COLORS.

EVERY photographer is acquainted with the fact that colors which look light will often photograph dark, while some colors that look dark photograph light. But I believe very few are aware of the fact that it is quite possible and practicable to entirely overcome this difficulty where short exposures are not essential.

Such a method is very valuable for copying oil paintings, and I use it to great advantage in making negatives of highly colored prints, and objects for photographs upon wood, where it is important that the details be very fine throughout.

Negatives of natural scenery, made in this way, are indescribably beautiful; the details develop richly throughout everything, whatever the color.

Hoping it may prove as useful to others as it does to myself, I will describe the method which I have perfected.

I place the object to be photographed in a strong light if possible, and use a quick working objective, directly in front of which is placed a lantern tank, having thin plate glass sides nearly half an inch apart. Fill the tank with a solution of bichromate of potash, containing one part of bichromate to 1,000 parts of water. Focus as usual; then prepare a plate with Newton's emulsion (I always manufacture it myself, and find it uniform and perfectly reliable) as follows:

As soon as the emulsion has set pour upon it a little alcoholic solution of chlorophyl (formula below), and float it backwards and forwards for about thirty seconds, after which wash until smooth. Flow with tea organifier (tea half ounce, water ten ounces), rinse, and expose about two and a half times as long as is required with the plain emulsion without the tank of yellow.

Develop with the sal-soda developer. (I make this double the strength recommended by Mr. Newton, and dilute where exposure is suspected.) If the bichromate of potash solution be too intense, blue and green will photograph too dark; if it be too weak, red will photograph too dark. I have given the proportions I find perfectly adapted to my tank, lens, and chemicals.

To prepare the chlorophyl, first extract everthing soluble in water from myrtle or tea leaves, by treating with a number of changes of hot water. Then dry the leaves, and the chlorophyl may be extracted at any time by treating about an ounce of leaves with four ounces of hot alcohol.

Myrtle leaves yield the most chlorophyl, the solution of which should be a deep, pure, green color, and will remain good for a long while if kept in the dark. It spoils very soon if exposed to a strong light.

In manufacturing Newton's emulsion I find it advantageous to mix it in the morning. Try a plate once each hour after, and add the chloride as soon as it fogs, which is sometimes within three hours. The emulsion will then be good at once, and remain so. Be careful to give full exposures. Better over than under expose, and judicious development will make perfect.

The lantern tank which I use is a "sciopticon tank," made to order with plate glass sides; it cost $1.25. Nothing could be better.

I have made two negatives from a highly colored chromo lithograph—one by the usual method, the other by the method described above. The difference is wonderful. The effect in the first is hard and unsatisfactory—the graduations of light and shade all wrong. The second is remarkably soft, delicate, and brilliant. The colors photograph harmoniously, and not a detail is lost. The value of this method for making copies of oil paintings will be readily appreciated.—*Fred. E. Ives, in Phil. Phot.*

PHOTOGRAPHY OF THE INVISIBLE.

CAPTAIN ABNEY, R. E., F.R.S., exhibited recently, before the Manchester L. & P. Society, his photographs of the ultra-red portions of the solar spectrum; and, first of all, showed that the light transmitted by ordinary bromide of silver was of an orange tint, showing absorption in the lowest end of the spectrum. He then went on to explain how he had tried to load the molecules comprising this bromide of silver by means of gum resins, and that he had thus been enabled to photograph slightly beyond the lowest limit of the visible spectrum. Further researches proved that bromide of silver could be prepared in two molecular states—one that already shown, and the other in which absorption takes place in the red as well as in the blue. This was found sensitive to every radiation. He pointed out that the blue form of the silver bromide could be converted into the red form by simple friction, and that after friction it was insentive to the ultra-red radiation.

Captain Abney then threw upon the screen photographs of the prismatic spectrum, in one of which the lowest limit of the prismatic spectrum was reached. He demonstrated this on the blackboard, by setting up as ordinates the wavelengths of the various portions of the photographs as obtained from the photographs of the diffraction spectrum.

THE RECENT TEXTILE DISPLAY.

THE attractive appearance of the third division of the late Grant reception procession, Philadelphia, which was devoted to textile manufacturers, gave universal satisfaction. There was a generous absence of all rivalry of firms. The marshal, Jas. Dobson (of John & James Dobson), rode at the head of the 4,000 forming this division. A remarkably beautiful banner of red silks, relieved by gold and silver tints, which proclaimed in letters of gold the fact that 50,000,000 of dollars is the capital invested in textile manufacture in this city, was indeed an interesting feature. Dobson's men, 500 in number, bearing flags and banners tastefully made of rugs, followed. A large truck, bearing a pyramid covered with carpets of Philadelphia manufacturers, drawn by four gray horses, and another, likewise decorated, with the "Philadelphia Wilton," drawn by four fine black horses, attracted much attention. 2,000 employes followed this, and next came a wagon completely covered with blankets and rugs, accompanied by 225 men of Seville Schofield, of Manayunk; William Schofield, marshal. Thomas Schofield had an omnibus drawn by four horses displaying his carpet yarns from River Road, Manayunk. Among others in line were Heft & Ogle, Joseph R. Davis, George Grobe, James Wallace, James & Davenport, James G. Davis, Charles Spencer, etc. Then followed the Fairmount section, numbering 300 men. Thomas Dolan & Co., manufacturers of cotton, woolen, and worsted goods, made a turn out of 600 men, headed by Gilmore's splendid band, of New York, composed of 65 pieces. The Quaker City Dye Works, of 100 men, was ably led by Mr. Harry H. Green, and presented a very creditable appearance. Clough & Carson, of the Fairmount Dye Works, made a good display. Also Firth Brothers & Co., Providence Dye Works. [We would here say that quite a number of dyers, not understanding there was to be an exhibition of dye-work, did not turn out, a fact which we exceedingly regret.] Conyers, Button & Co., hosiery and knitted goods, had 8 wagons and 150 men; J. & B. Allen, knitted goods, 100 men wearing badges and regalia; McCallum, Crease & Co., had 400 uniformed men; Charles Spencer & Son's knitting mills, 120 men; Schofield & Branson, 150 men, Thomas P. Stokes & Sons, woolen mills; also Joseph Scanlin & Sons, Foster & Williams, and others. Robert J. Walker's Star Finishing Works, with the West Philadelphia Band in advance, and having a wagon handsomely decorated, turned out in force. Shaffner & Stringfellow, wool and knitting cotton manufacturers, had also a tastely decorated wagon. William Wood, cotton and wool manufacturer, made a creditable turn out. H. W. Butterworth & Sons had on a wagon a drying machine in full operation. This is but a meager notice of the elegant display made on this occasion by our textile friends, but it must be sufficient to say that they have earned a right to be proud of themselves, as Philadelphia must surely be proud of them and their works.—*Textile Colorist.*

ARTIFICIAL DIAMONDS.

AFTER 13 years of experiment, Mr. James MacTear, of the St. Rollox Chemical Works, Glasgow, has succeeded in obtaining "pure crystalline forms of carbon," which, it appears, Prof. Tyndall, Prof. Smyth, and Mr. Maskelyne, of the British Museum, do not doubt to be true diamonds. Even when the results are from an economic aspect inconsiderable, the artificial formation of any substance hitherto known solely as a natural product must always be regarded as a great triumph in organic chemistry. In the laboratory the marvelous chemical discoveries of recent years have in a great measure reduced the production of diamonds to a question of time and patient experiment, but the general certainty of ultimate success does not in any way detract from Mr. Mac Tear's brilliant discovery in synthetical mineralogy. He is rather to be congratulated on his indubitable claim to priority, for the dual discovery of the planet Neptune, of the metal thallium, of liquid oxygen, and a number of other curious coincidences in the history of scientific research, suggest the possibility, if not the probability, of other alchemists testing with half incredulous delight the tiny crystals which they almost tremble to identify with the natural gem. Chemistry has so widened belief in the magic of the laboratory that antique impossibilities have become modern difficulties, and the synthesis of the diamond in particular seems a feat which one would be justified in regarding as likely enough. Eleven years ago two German chemists produced from gas tar the coloring principle of madder, and the Turkey red which we formerly obtained from the fields of France, Holland, and the Levant we now order from the chemical factory. Last year Prof. Baeyer, of Munich University, succeeded in building up the blue coloring matter of indigo from the comparatively common substance known as phenylacetic acid, and the scientific triumph is none the less because there appears no present hope of artificial indigo taking the place of the vegetable dye. In the previous year, 1877, oxygen, nitrogen, hydrogen, and other so-called permanent gases were liquefied; the very air we breathe was condensed to a liquid jet; hydrogen was shown to be the vapor of a metal and water a true metallic oxide; and the imagination was enabled to add to the terrible picture of a sunless world, with its rivers of ice and its petrified seas, an atmosphere turning, in a state of disintegration, from invisible gases to strange liquids and new metals. The production of artificial, not imitation, rubies in the same year by MM. Fremy and Fell seemed especially to herald the production of the diamond. Of all precious stones the ruby is the most valuable. When even of only a moderate size a diamond of equal weight is but one-tenth its worth. Chemically it is pure alumina—the oxide of aluminum, which enters largely into the composition of ordinary clay. Such an aluminate as that of lead when heated with silicious or flinty matter, gives a fused mass, from which on cooling free alumina separates in crystalline forms—true rubies if the chemist shall have added a small proportion of bichromate of potassium; true sapphires, if a trace of the bichromate and a little oxide of cobalt. In specific gravity and in the system of crystallization the

artificial stone and the ruby are identical; they differ in no wise, unless, indeed, it be a fact that the lapidary has found the hardness of the artificial to excel that of the natural gem. We are not aware of the process by which Mr. MacTear has produced his diamond crystals, and though up to the present they have stood the tests of acids, alkalies, and the blowpipe, their hardness, refractive index, measurement of angle, and, we presume, their density, have yet to be established as identical with those of the diamond in nature.

It need hardly be added that it will be a source of general gratification if these latter results can be obtained, and they will be waited for with eagerness. Diamonds have from time immemorial fascinated the popular imagination. The fairyland of the nursery glitters with diamonds, and the heaven of the mature belief can only be pictured to the vision by the color and brilliancy of jewels. Medicine of old found its panacea in gems, and the search for the philosopher's stone was the genesis of chemistry. In Pliny's days the six varieties of diamonds were solely in the possession of the most luxurious kings, and royalty has amassed them ever since. The spots where they have been found have been the goals of human desire and the theaters of human passion, suffering, and crime. Through centuries of history a handful of them have outshone the memorable eyes of beautiful women and the swords of a thousand heroes. The Six Paragons are more famous than the Seven Champions of Christendom, and their romances are more enthralling than Wilkie Collins'. The Orloff diamond in the Czar's scepter was the eye of an Indian idol; the Florentine was lost by Charles the Rash on the ill-fated field of Granson, and was sold for a few pence by a Swiss soldier who found it; our own Koh-i-noor was reputedly worn 5,000 years ago by the hero of the Hindoo epic, the "Mahabharata," and at a later period was wrested from the Khan of Cabul by Runjeet Singh, who decked his horse with it on high festivals. For the great diamond of the Rajah of Mattan, in Borneo, $150,000, two large war brigs and a complete store of arms and ammunition were refused. A large diamond, supposed to be part of a huge gem of which the Orloff and Koh-i-noor are fragments, was found in the hands of a peasant who used it as a flint to light his fire. The first Brazilian diamonds were, in 1727, recognized among negroes, who used them as counters in card-playing; and the first Cape diamond, given to a Scotch farmer in 1867, and sold at the Paris Exhibition for £500, was the plaything of a Boer's children.

In all the great geographical divisions diamonds have been discovered, but the European specimens are few and small. Only about 70 were gathered in 20 years in the gold washings near the iron mines of Bissersk, at the foot of the Ural Mountains; and Diaschkowitz in Bohemia is notable for a solitary gem. None have been found elsewhere in Europe. The occurrence of the diamond in mica slate and in or near igneous rocks, and especially in the "pans" or "pipes" at the Cape, favors the view that it owes its origin to heat or metamorphic action, and that it has been brought to the surface with volcanic matter. Newton considered it "an unctuous substance coagulated;" Jameson, the secretion of an ancient tree, like amber; Brewster traced it to a vegetable source; in 1842, Petzhold stated that in its ashes he had discovered traces of plant tissues and vegetable cells; while Liebig and others believed it was formed by a slow process of decomposition in a fluid rich in carbon and hydrogen. Its inflammable nature was conjectured as early as the 16th century, and was proved at Florence in 1694. Lavoisier determined the product of combustion to be carbonic acid gas, and by the aid of the "pure crystallized carbon," Sir George Mackenzie, in the most expensive process on record, converted iron into steel. Analysis of a substance which, when the air is excluded, resists the maximum heat of a porcelain kiln and the temperature at which pig iron melts, can be conceived to have presented considerable difficulties; but with diamonds, as with our neighbor's character, it is easier to pull to pieces than to put together again. Synthesis is a triumph of an infinitely higher order. However, even if Mr. MacTear's experiments have solved the puzzle of mediæval alchemy, it remains yet to be proved whether in a commercial sense they can have much influence on the value of the natural diamond. It is the peculiar interest in the laboratory ruby that the gem has been prepared in such quantity as to be available in the arts. The glass furnace, it is stated, has yielded "a crystalline mass (of ruby) weighing several kilogs." Mr. MacTear's crystals measure but 1-32d of 1 in. Future experiments under improved conditions may, indeed, produce crystals of sufficient magnitude to supersede the natural diamond in various of its technical uses, it may even involve a huge commercial catastrophe and manifold domestic tragedies; but until such an experiment has been successfully wrought out it is not likely that the panic of 1733 will fall on the jewelers of 1879. In any case, invention will never vulgarize the historic jewels of empires and the heirlooms of great houses.—*Glasgow Herald.*

THOSE ARTIFICIAL DIAMONDS.

DR. CROOKES, editor of the *Chemical News*, has tested the supposed artificial diamonds with the following results: Since sending the telegram announcing that carbon crystals, apparently diamond, could without difficulty be produced from any carbon compound, Mr. MacTear has sent me several specimens of his supposed artificial diamond. He has also called upon me with other specimens, and has explained the whole process by which he obtains such remarkable results. As, however, he has sent to the Royal Society a paper which will probably be read in the course of a week or two, I am not yet at liberty to give details of the process.

The general character of the specimens now in my possession may be described as irregularly shaped masses from 1 mm. downwards in diameter, with rounded angles, and showing no definite crystalline appearance. They are whitish looking, translucent, and, as a rule, lusterless; many pieces are almost spherical, and appear like fragments of corundum which have been water worn. Among these are perfectly clear fragments larger in size, some being 3 or 4 mm. across, having a conchoidal fracture exactly like glass.

In a paper "On Molecular Physics in High Vacua," read before the Royal Society in March last, and now being published in the *Philosophical Transactions*, I referred to the remarkable power possessed by the molecular rays in a high vacuum of causing phosphorescence in bodies on which they fall, and I remarked that the only body which surpassed Becquerel's luminous sulphides both in brilliancy and variety of color is the diamond. Most of these gems, whether cut or in the rough, when coming from the South African fields, phosphoresce of a brilliant light blue color. Diamonds from Brazil shine with different colors, such as bright blue, pale blue, apricot, red, yellowish green, orange, and light green. A beautiful collection of diamond crystals, kindly lent me by Professor Maskelyne, phosphoresced with nearly all the colors of the rainbow, the different faces glowing with different shades of color. On receiving the specimens from Mr. MacTear, I immediately submitted them to the molecular discharge. The following are the results I have at present obtained:

In a high vacuum the specimens phosphoresce brightly of different colors—pale blue, orange, apricot, and yellowish green. The clear, glassy fragments are also phosphorescent. The appearance of the phosphorescence is very similar to that shown by small, rough diamonds from Brazil, called in the trade "boart;" indeed, had I not known the history of the fragments in my tube, I should, from their appearance, have said that they were small fragments of Brazilian boart.

The opaque, rounded appearance of the fragments is unlike that of the natural diamond, but by heating a rough diamond before the blowpipe until it has partly burnt away, it assumes a very similar appearance to that of Mr. MacTear's crystals, and it is therefore not unlikely, from their mode of preparation, that these crystals have undergone partial combustion after their formation—a fact which would explain this difference in appearance. Other specimens having been placed by Mr. MacTear in competent hands, with a view of determining their hardness and chemical properties, I have refrained from making experiments in this direction.

THE ARTIFICIAL MANUFACTURE OF DIAMONDS.

A FEW days ago it was announced that Mr. James MacTear, of the St. Rollox Chemical Works, had intimated to the Glasgow Philosophical Society his discovery of how to produce artificial diamonds. This work has long attracted the attention of chemists; for it is known that diamonds are nothing more than the crystallized form of ordinary charcoal. How to transform the charcoal into crystals is the puzzle which for years they have set themselves to solve. Mr. MacTear's announcement that he has satisfactorily solved it has brought into notice the claims of a young gentleman in our own town to prior discovery. Mr. R. S. Baxter, Magdalen Place, Dundee, began his experiments in this direction in 1876, but was without successful results until April, 1877. In that month he obtained a few crystals, which unfortunately, were lost through careless handling. He endeavored to procure more, but for several months did not succeed. In January, of this year, he sent an account of the experiments to *Nature*, but the editor of that journal, being of the opinion that they were not sufficiently matured, thought it inexpedient to publish them. Specimens of the crystals have now been submitted to Prof. Tyndall. We have had an opportunity of inspecting them, and to the eye they have the appearance of gray granular dust. On seeing them under a microscope their crystalline form is at once apparent. Not being cut or polished, they do not of course have the sparkle of "brilliants." They are considerably mixed with unconverted carbon, and are apparently in all stages of conversion from black opacity to clear transparency. Many are translucent, while others are translucent with black spots. They have been tested with acids, caustic potash, etc., and are found to be quite insoluble. They scratch topaz as well as glass. There can be no doubt of the genuineness of the crystals, and it now only remains to get them of larger size. With attention and the necessary apparatus this may perhaps be effected, but these crystals do very great credit to the perseverance and ingenuity of an amateur. Their present size can be produced in any quantity at comparatively a low cost, and probably they will be serviceable as diamond dust.—*Dundee (Scotland) Advertiser.*

CHEMICAL SOCIETY.

London, December 18, 1879.—Mr. WARREN DE LA RUE, President, in the Chair.

ON THE SPECIFIC VOLUME OF CRYSTALLIZATION.

By T. E. THORPE and J. J. WATTS.

SOME years ago Playfair and Joule pointed out that the volumes of certain highly hydrated salts, as, for example, sodium carbonate with 10 molecules of water, also the alkaline arsenates and phosphates with 12 molecules, are equal to that of the water, considered as ice, which they respectively contain: thus the molecules of the salt seem to exist in the interstitial spaces of the ice. This law does not hold good for salts less highly hydrated. Thus, in borax, sodium pyrophosphate and the normal aluminum sulphate the volume seems to be made up of the water considered as ice, together with that of the base as existing in the free state. Schiff has shown that members of certain classes of hydrated salts have the same specific volume. Thus all the alums have a specific volume 277, double sulphates, $M_2M'(SO_4)_2$, 207, and the vitriols, $M'SO_4 7H_2O$, 146. The authors have determined the precise relation between the specific volumes of various sulphates of copper, magnesium, zinc, nickel, cobalt, iron, and manganese, and their respective degrees of hydration. They have incorporated in the present paper some results placed at their disposal by Dr. Playfair. Details of the preparation and analysis of the various hydrates employed are given. The specific gravity was determined by weighing in benzine at 15°C. The results are contained in the following table:—

Hydrate.	0.	1.	2.	3.	4.	5.	6.	7.
$CuSO_4$	44·4	54·3	67·0	80·0	—	109·1	—	—
$MgSO_4$	44·8	55·6	67·0	—	—	112·4	130·8	146·8
$ZnSO_4$	45·6	54·7	66·6	—	—	113·7	130·2	146·8
$NiSO_4$	44·6	56·5	—	—	—	—	129·0	144·6
$CoSO_4$	44·7	55·2	70·9	—	97·4	114·6	130·1	146·0
$MnSO_4$	45·0	55·7	73·6	86·6	98·2	114·4	—	—
$FeSO_4$	44·5	56·2	67·7	—	100·5	—	—	146·7
Means	44·8	55·5	68·8	82·3	98·7	112·9	130·0	146·2

From these results it appears that, in the case, at least, of the so-called magnesian sulphates, the volumes occupied by the several molecules of water varies with the degree of hydration. The first molecule, the "constitutional water" of Graham, occupies less bulk than any other. Its mean relative value is 10·7. The value of the second is 13·3; of the third, 14·5; of the fourth, 15·4; of the fifth (taking the mean of the most concordant numbers, $ZnSO_4$, $CoSO_4$, and $MnSO_4$), 15·6; of the sixth, 15·7; of the seventh, 16·2. These results accord with the fact that the different molecules of water in a hydrated salt are held with various degrees of tenacity, as shown by the different intensities of heat needed to expel them, the amount of energy required standing in some relation to the degree of condensation in the combined molecule. The authors point out the importance of estimating the amounts of heat resulting from the combination of successive molecules of water with the different sulphates. Graham has already shown that more heat was evolved in the combination of the first molecule than in that of any of the remaining molecules. In other words, that the amount of heat developed is related to the degree of condensation of the combined molecules. As the foregoing numbers express the volumes in cubic centimeters of the equivalent of the salts in grammes, it appears that equivalent quantities of these different sulphates occupy respectively the same volume in space, or, in other words, the unit volume contains the same number of molecules of the different salts.

NOTE ON THE FORMATION OF OZONE DURING THE SLOW OXIDATION OF PHOSPHORUS.

By Prof. MCLEOD.

The active substance formed during the slow oxidation of phosphorus is probably either ozone or peroxide of hydrogen. The latter substance is readily destroyed by alkalies, a solution of chromic acid, or a solution of alkaline permanganate, while ozone is unaffected either by a solution of sodic carbonate or by chromic acid, and appears to be only slightly attacked by alkaline permanganate. Air in which phosphorus was slowly oxidizing was drawn through a U tube 9½ inches long (filled with fragments of glass, containing in succession sodic carbonate saturated with carbonic anhydride, a mixture of potassic dichromate and sulphuric acid, and potassic permanganate previously saturated with carbonic anhydride), and then into a flask containing a solution of potassic iodide and starch. In all cases the latter solution became blue, both when the U tube was cold and when heated to 100°. Similar results were obtained when a U tube 12½ inches long was used, packed with small pieces of pumice and saturated with solution of sodic carbonate. The effect of heat on the gas was tried. The gas was aspirated through a narrow U tube, which was heated to 150° and 200°. Beyond this U tube were placed, first, a weighed U tube packed with pumice and sulphuric ac'd, and, secondly, a flask with solution of potassic iodide and starch acidified with sulphuric acid. The U tube was weighed before and after each experiment, and the blue solution titrated with decinormal sodic thiosulphate. The gas was aspirated at the rate of 1 liter per hour. The following results were obtained:—

Gas Aspirated.	Temp. of U tube.	Increase of Sulphuric Acid tube.	Thiosulphate Used.
4,600 c.c.	cold	0·0026 grm.	2·35c.c.
2,760 "	100°	0·0008 "	1·9 "
4,600 "	150°	0·0026 "	3·2 "
2,760 "	200°	0·0006 "	1·8 "

1 c.c. of thiosulphate = 0·017 grm. of hydroxyl, which on decomposition forms 0·009 grm. of water; and as at least one-half of the hydroxyl might be assumed to be decomposed, an increase of the sulphuric acid tube in the last experiment should be 0·016 grm. instead of only 0·0006. Hydroxyl combines with acids. The gas from phosphorus was exposed to the action of strong sulphuric acid for four days without losing its activity. It is extremely improbable that ozone and hydroxyl are both formed, as these substances destroy each other. The author therefore concludes that the gas obtained during the slow oxidation of phosphorus possesses the properties of ozone, and not those of hydroxyl, the only known peroxide of hydrogen.

Mr. KINGZETT had listened to the paper with great interest. Up to the present time no evidence had been put on record to prove that this gas from phosphorus contained ozone, and as he had shown that certain hydrocarbons which had been supposed to produce ozone really formed hydroxyl, he had assumed, in the absence of any evidence, that hydroxyl was formed in this case. After referring to the researches of Cornu, Mr. Kingzett said that he could confirm the observation of Prof. McLeod that peroxide of hydrogen and ozone in the presence of an acid did not decompose each other.

ON THE ANALYSIS OF ORGANIC BODIES CONTAINING NITROGEN.

By W. H. PERKIN.

Some years since, the author wished to determine the halogens as well as the carbon and hydrogen in bodies containing nitrogen. The substance was burnt in oxygen, and the products of combustion passed over a weighed quantity of pure metallic silver. The difficulty arose as to how to get rid of the nitrous fumes: plumbic peroxide was first tried between the water absorbing apparatus and potash bulbs. This succeeded as far as the carbon was concerned, but as nitrous fumes were absorbed by the sulphuric acid the hydrogen determinations were too high. Plumbic peroxide was then placed in the combustion tube, but great difficulty was experienced in heating it to just the proper temperature. Potassic chromate was then tried, and was found to succeed admirably; it absorbed the nitrous fumes completely, had no action on carbonic anhydride, and could be heated without fear. The author therefore recommends the use of about 6 to 7 inches of potassic chromate in the combustion of all substances containing nitrogen instead of freshly reduced copper, which is very hygroscopic and occludes hydrogen, or of silver, which requires an inconveniently high temperature. The potassic chromate should be free from an excess of alkali; a trace of bichromate is not harmful, though bichromate does not work so well as chromate. The chromate should be roughly powdered or granulated by evaporating its solution to dryness with constant stirring; or, still better, coarsely-powdered pumice saturated with solution of chromate may be used. The chromate should be kept at a scarcely dull red-heat. The author does not state how many times the chromate can be used. Chromate also absorbs sulphurous acid. It does not retain iodine vapor, but would be probably useful with substances containing chlorine or bromine.

COLORED RINGS ON MERCURY.

By M. ADR. GUEBHARD.

IF the gray pellicle formed on the surface of impure mercury is carefully swept away, a surface is obtained the brightness of which is, for the moment, as great, and the mobility less, than those of pure mercury. The moisture of the breath produces upon such a surface magnificent systems of colored bands. More striking results are obtained on substituting for the breath the vapors of certain volatile substances, such as the common essence of petroleum. With collodion diluted with ether the author obtains pellicles which may be detached from the mercury after having regulated the color and the thickness at pleasure.

[AMERICAN CHEMICAL JOURNAL.]

ON A NEW METHOD FOR THE SEPARATION AND SUBSEQUENT TREATMENT OF PRECIPITATES IN CHEMICAL ANALYSIS.[1]

By F. A. GOOCH.

THE introduction of Bunsen's method of filtration and immediate ignition of precipitates in the moist condition has left little to be desired as regards accuracy of result and rapidity of execution, in the treatment of precipitates which may be submitted to high temperatures in contact with carbonaceous matter. In analytical methods which require that filter paper and precipitate shall be ignited apart, or dried together at a temperature below the point at which paper begins to char, the same degree of exactness has not, in general, been hitherto attained.

To obviate the difficulty of bringing a paper filter of ordinary dimensions, particularly when covered with a voluminous precipitate, to a definite condition of desiccation, the sand filters of Dr. Gibbs and Taylor,[2] the porous cones of Munroe,[3] and finally the process of reverse filtering, first applied to quantitative work by Carmichael,[4] improved by Casamajor,[5] and thoroughly elaborated by Professor Cooke,[6] have been successively brought forward.

The latter process gives most excellent results in the separation of precipitates which settle quickly and completely; and, inasmuch as many precipitates which of themselves are not inclined to fall rapidly may be made to do so by proper treatment (by boiling, for example, the addition of ammonium salts, Chatard's[7] method of granulating gelatinous precipitates or other similar device), the field of usefulness of this process is wide.

The sand filters in skillful hands, and the porous cones with no more than ordinary care, give accurate results, and possess, moreover, the advantage of being applicable to the filtration of liquids which quickly destroy woody fiber. The length of time required to dry them thoroughly, and their sensitiveness to atmospheric conditions, are their great drawbacks.

For the simple filtration of corrosive liquids without reference to a subsequent estimation of the precipitate, filters of sand, broken glass, garnets, and fibrous asbestos have for a time been used. More recently asbestos has been moulded into the shape of an ordinary filter; in the dry state by Loewe,[8] by rubbing between hollow and a solid wooden cone; in the wet state by Gruner,[9] by grinding asbestos, mixed in a mortar with water, to a pulp, transferring the mixture to a funnel choked with asbestos, inserting an accurately fitting cone of brass gauze, which presses the asbestos against the walls of the funnel, pouring off the water, carefully removing the cone, and drying the layer of asbestos which adheres to the glass. Böttger[10] has used filters of gun cotton; and Bunsen[11] has devised a filtering apparatus for corrosive liquids to be attached to his pump, which consists of a disk of artificial pumice fitted to a conical tube and packed round its edge with fibrous asbestos.

None of these later-mentioned methods, however, are well adapted to the quantitative estimation of precipitates.

Impressed with the desirability of further improvement in those processes of quantitative analysis which involve the use of dried filters, or the separation of filter and precipitate before ignition, I have had the good fortune, in taking the matter up in turn, to succeed in devising and preparing a felt of anhydrous asbestos, which is capable of filtering liquids with a rapidity and efficiency at least as great as may be obtained by the use of good filter paper; is light, compact, incombustible, at the highest temperatures used in analytical processes; is not acted upon by acids (excepting hydrofluoric acid) or alkalies; is sufficiently coherent to resist entirely the disintegrating action of a liquid forced through it under the pressure of the Bunsen pump, and which may, moreover, be prepared by a very simple process; in short, a filtering material which, in my belief, makes it possible to reach a high degree of accuracy in many analytical processes which hitherto have been none of the best, and to add to those already known new methods which previously have been impracticable.

My mode of preparing and using the asbestos felt is as follows:

First, white, silky, anhydrous asbestos,[12] is scraped to a fine short down with an ordinary knife blade, boiled with hydrochloric acid to remove traces of iron or other soluble matter, washed by decantation, and set aside for use.

Secondly, a platinum crucible of ordinary size, preferably of the broad low pattern (Fig. 1), is chosen, and the bottom

FIG. 1.

(Fig. 2) perforated with fine holes (the more numerous and the finer the better) by means of a steel point; or, better still, the bottom may be made of fine platinum gauze. Next, a Bunsen funnel of the proper size is selected, and—following Munroe's plan for holding his porous cones—over the top a short piece of rubber tubing is stretched and drawn down until the portion above the funnel[13] arranges itself at right angles to the direction of the stem. Within the opening in the rubber, the perforated crucible is fitted as shown in Figure 3, and the funnel is connected with the receiver of a Bunsen pump or other exhausting apparatus in the ordinary manner.

To make the asbestos felt, the pressure of the pump is applied, and a little of the asbestos prepared as described, and suspended in water, is poured into the crucible. The rubber and the crucible are held together by the pressure of the vacuum pump with sufficient force to make an air-tight joint; the water is drawn through, and the asbestos is deposited almost instantly in a close compact layer upon the perforated bottom; more asbestos, if necessary, in suspension as before, being poured upon the first, until the layer becomes sufficiently thick for the purpose for which it is intended. Finally, a little distilled water is drawn through the apparatus to wash away any filaments that might cling to the under side, and the filter is ready for use, the whole process occupying less time than is necessary to fold and fit an ordinary paper filter to a funnel.

FIG. 2.

FIG. 3.

To prepare the filter for the estimation of a precipitate, the crucible with the felt undisturbed is removed from the funnel and ignited. In case the precipitate, to be subsequently collected, must be heated to a very high temperature for a long time, it is better to inclose the perforated crucible with its felt within another crucible; because, in such cases, asbestos felt is apt to curl at the edges, and without such precaution some of the precipitate might drop through the perforations and be lost. For drying at low temperatures, however, and even for ordinary ignitions, a second crucible is unnecessary; but, during the ignition of an easily reducible substance, care must be taken to prevent the contact of unburnt gas with the perforated bottom.

To perform the filtration, the crucible is replaced in the funnel, the pressure applied, and the process conducted precisely as in an ordinary filtration by the Bunsen pump. It is necessary to observe that the vacuum pump is to be started before pouring the liquid upon the filter. The final drying or ignition, as the case may be, of precipitate and filter is made without difficulty, or need of extra precaution.

When turbid liquids are to be filtered, or gelatinous precipitates to be separated, instead of the perforated crucible,

FIG. 4.

I prefer to use a platinum cone (Figs. 4 and 5), the upper part of foil (to make a tight joint with the rubber fitting of the funnel), the lower of gauze. The method of covering the gauze with felt is identical with that described above. By reason of the larger filtering surface of this apparatus, the tendency to become clogged is, of course, very much diminished. When subjected to prolonged ignition, the gauze cone is encircled within a crucible or a cone of platinum foil.

In operations in which platinum is liable to receive injury, a porcelain crucible, with a perforated bottom, may be

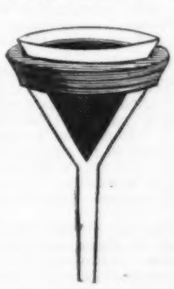


FIG. 5.

used; but recourse to this is rarely necessary, particularly when one may use the gauze cone, protected, as it is, by asbestos felt; moreover, the perforation of porcelain with numerous fine holes is a matter of considerable difficulty and expense.

Asbestos felt may be also used in the process of reverse filtering, it being merely necessary to dip the platinum rose into the asbestos mixture, after starting the vacuum pump, in order to make the felt. The rose, with the felt attached, and the vessel in which the precipitate is collected, are to be weighed together, both before and after filtration.

Nothing can be simpler than the whole method of preparation and use of the apparatus which I have described, and its efficiency is extremely great. Clean water may, under the pressure of a Bunsen pump, be passed through a gauze cone coated with asbestos felt, which exposes a filtering surface of twenty-four square centimeters (nearly the same as that of a paper filter eight centimeters in diameter, when folded in the ordinary manner), with ease at the rate of a liter per minute.

When the filtering surface is less, the rapidity of filtration is, of course, somewhat diminished, but, supposing the asbestos used to be of the best quality, always exceeds that of paper of the same dimensions. When the felt is deposited upon gauze, the layer may be suprisingly thin and yet be efficient enough for all ordinary purposes. If the layer of felt be quite thick, the filtrate from baric sulphate freshly precipitated in the cold, may be made to pass through clear. But the great superiority of asbestos felt lies in its constancy of weight, whether dried at high or low temperatures, the rapidity with which it may be safely and completely dried, and its refractoriness as regards acids (excepting hydrofluoric acid) and alkalies. These advantages appear most prominently in processes which involve the separation and desiccation:

First, of precipitates which (like K_2PtCl_6, $[Hg_x]Cl_x$) must be dried at low temperatures, on account of a tendency to decompose spontaneously at high temperatures.

Secondly, of precipitates which (like Sb_2S_3, $PbSO_4$, $ZnCO_3$) have usually been dried slowly and tediously at low temperatures, or have been separated from the filter before ignition, to avoid the danger of reduction by heating in contact with carbon.

Thirdly, of precipitates which (like $(NH_4)_2Mg_2P_2O_7$, $(NH_4)_2Mn_2P_2O_7$) may be ignited in contact with carbon, but which makes its complete combustion difficult.

In all cases, the time required to dry or ignite, precipitate, and filter is a minimum, inasmuch as heat may be applied as soon and to as high a degree as the precipitate itself will permit. Even in processes in which paper filters find their most convenient application, paper has generally no superiority over asbestos felt.

To illustrate the cohesiveness and refractory nature of the felt, I append the account of a single experiment. All of the liquids used had been previously filtered, excepting the distilled water with which the filter was washed, after the passage of each liquid. This precaution was considered unnecessary in the case of the water; but, if it had been taken, the slight *increase* of weight which was observed during the experiment would probably have been prevented.

Weight, in grammes, of crucible and felt, after ignition	20·2020
After second ignition	20·2020
After passing 100 cm.³ of strong HCl through the filter *ten* times, washing and igniting	20·2020
After passing 100 cm.³ of strong HNO_3 through the filter *ten* times, washing and igniting	20·2021
After passing 100 cm.³ of strong H_2SO_4 through the filter *five* times, washing and igniting	20·2022
After passing 100 cm.³ of a mixture of strong H_2SO_4 and water in parts, *ten* times through the filter, washing and igniting	20·2024
After passing 100 cm.³ of water, containing in solution 50 grammes of NaOH *ten* times through the filter, washing and igniting	20·2028
Weight of crucible	20·1932
" " felt	0·0088

The whole process, involving, in all, the filtration of five liters of liquid (of which one liter was viscous), more than forty changes of the receiver, together with the ignition, cooling, and weighing of the crucible and felt seven times, was completed in two hours and ten minutes. The disk of felt was eleven millimeters in diameter.

ASPHALTUM.

FOR fifty years asphaltum has been used in photography without chemists having come to any distinct conclusion as to its nature. They were content with merely analyzing the substance, which was evidently a mixture, giving as its components carbon, hydrogen, and oxygen. In 1877 Helm first showed that asphaltum also contained a very considerable quantity of sulphur. That asphaltum was no simple substance, but a mixture, was undoubted.

Ten years ago Professor Liebermann conjectured that asphaltum contained anthracene, and that this was the cause of its sensitiveness to light, and he established the fact that anthracene is changed by light into insoluble paranthracene. On a close examination, however, no anthracene was detected in the asphaltum. Dr. Kayser, of Nürnberg, then undertook the meritorious work of investigating minutely the components of asphaltum and the cause of its sensitiveness to light, and has now published the result of his labors in a small pamphlet,* which we recommend to the attention of heliographers. He shows that Syrian asphaltum and Trinidad asphaltum are separated by treatment with ether and alcohol into three parts—one soluble in alcohol, one soluble in ether, and one insoluble in both fluids.

Syrian asphaltum contains four per cent. of the substance soluble in alcohol (sp. gr. 0·835—a yellow oily mass having an intensely bituminous smell); forty-four per cent. of the substance is soluble in ether, which forms a brownish black, resinous, brittle mass, almost without smell, melting at 65° C.; and lastly, fifty-two per cent. of the insoluble substance. The latter is a black, very brittle mass, free from smell, which melts at 156° C., and is easily dissolved in chloroform and oil of turpentine, and with difficulty in benzole and petroleum. Its solutions have a brown color and a green efflorescence.

Trinidad asphaltum behaves analogously, containing about five per cent. of the substance soluble in alcohol, fifty-seven per cent. of that soluble in ether, and thirty-eight per cent. of that insoluble in both fluids. All these substances contain sulphur. In the case of the Syrian asphaltum, the first contained about seven per cent., the second about ten per cent., and the third thirteen per cent.

According to Dr. Kayser's analysis the composition of the soluble parts varies with the sort of asphaltum. Thus, he gives as the formula of the part of Syrian asphaltum soluble in alcohol, $C_{29}H_{46}S$; for the corresponding part of Trinidad asphaltum, $C_{29}H_{48}S$; for the part of Syrian asphaltum soluble in ether, the formula $C_{41}H_{62}S_2$; and for the same part of Trinidad asphaltum, $C_{21}H_{32}S$. On the other hand, the composition of the insoluble part of both sorts is the same—$C_{29}H_{42}S_2$.

ANALYSIS OF SYRIAN TRINIDAD ASPHALTUM.

(a) Soluble in boiling alcohol (sp. gr. 0·835) four per cent.; formula, $C_{29}H_{46}S$.

[1] Presented to the American Academy of arts and Sciences. Communicated by the author.

[2] *Am. Jour.* [2], vol xliv., p. 215.

[3] *Am. Jour.* [3], vol i., p. 1

[4] *Zeitschr. f. Chem.* [N. F.], Bd. 6, p. 481.

[5] *Am. Chem.*, vol. v . p. 441.

[6] *Proc. Am. Acad. Arts and Sci.*, vol. xii., p. 124.

[7] *Am. Jour* [2], vol. l., p. 247.

[8] *Dingl. pol. Jour.*, cxlviii., 444.

[9] *Jahresb. Chem.*, 1860, p. 990.

[10] *Dingl. pol. Jour.*, clv., p. 468.

[11] *Ann. Ch. Pharm.*, cxlviii , p. 290.

[12] Note, November, 1879. I have found it very hard to procure asbestos of the proper quality from dealers in this country; but it would appear from the fact that several lots imported from Germany at different times have proved to be serviceable, and some of them excellent, that the difficulty is not due to a scantiness in the natural supply.

[13] Note, November, 1879. It is better, as Professor H. B. Hill suggests, to leave a margin of the inner edge projecting upward.

* "Investigations of Natural Asphalts, with Special Reference to their Photo-Chemical Properties." By Dr. R. Kayser, Nürnberg, 1879.

(*b*) Soluble in ether forty-four per cent.; formula, $C_{21}H_{12}S_2$.

(*c*) Insoluble in above, soluble in chloroform fifty-two per cent.; formula, $C_{21}H_{12}S_2$.

(*b*) Melts at 65° C.; (*c*) at 150° C.

ANALYSIS OF TRINIDAD ASPHALTUM.

(*a*) Soluble in alcohol five per cent.; formula, $C_{21}H_{12}S$.

(*b*) Soluble in ether fifty-seven per cent.; formula, $C_{21}H_{12}S$.

(*c*) Insoluble in above, soluble in chloroform thirty-eight per cent.; formula, $C_{21}H_{12}S_2$.

(*b*) Melts at 54° C.; (*c*) at 150° C.

The proportions vary with the different sorts of asphaltum, as in the case of the asphaltum from Bechebroun (Bas Rhin), which virtually consists of carbureted hydrogen, while Maracaibo asphaltum behaves analogously with that from Trinidad and Syria. Asphaltum from Barbadoes occupies a middle place between that from Bechebroun and that from Syria. The photo-chemical behavior of asphaltum is of great interest, but on that point we shall quote from Dr. Kayser himself:

"Until now it has been assumed (apparently under the influence of the idea that asphaltum itself is to be looked upon as the product of the oxidation of earthy oily bodies—that is to say, of heavy carbureted hydrogen) that an oxidation of asphaltum takes place under the influence of light, and that this oxidized asphaltum has lost its solubility.

"It was, however, proved by these experiments that in Syrian and Trinidad asphaltum—these being the kinds which principally find their way into the markets and are used in photography—no oxygen is contained, but that they should rather be considered as sulphureted hydrocarbons; therefore, the view of exposure to light causing oxidation is not very tenable, even if not altogether excluded."

The elementary composition of Syrian and Trinidad asphaltum he gives as follows:*

	Syrian asphaltum.	Trinidad asphaltum.
Carbon	80·0 per cent.	78·8 per cent.
Hydrogen	9·0 "	9·3 "
Sulphur	10·0 "	10·0 "
Nitrogen	0·6 "	0·5 "
Ashy residue	0·4 "	1·4 "
	100·0	100·0

"In order to examine the question more closely, and so perhaps to find the answer to it, the following experiment was undertaken: Five grammes of picked pieces of Syrian asphaltum were dissolved in two hundred grammes of pure chloroform, and with the solution some glass plates (the exact weight of which had been previously ascertained) were coated on one side, and, after the chloroform had evaporated, the plates on which the coating of asphaltum had remained were dried in a dark room at 100° C. until they reached their constant weight. The asphaltum film transmitted the light of a pale brown color, and when dry was very easily dissolved in oil of turpentine, or in a mixture of *two parts of oil of turpentine and one part of olive oil*. The plates so prepared with their coating of asphaltum were exposed for several days to light—often, indeed, to the direct light of the sun—in the month of June, and, therefore, in a month during which the average daylight is powerful. During this time the plates were weighed twice a day—at midday and at five in the afternoon; but in no case was any observable alteration of weight, either increase or decrease, to be detected in the asphalted glass plates, even after seventy-two hours of exposure, after which time the asphaltum film had become insoluble in the above mixture of olive oil and turpentine.

"As the quantity of asphaltum on each plate varied from three to five decigrammes, even a very slight increase caused by the action of the oxygen of the air would have revealed itself by a change in the weight, especially if actual oxidation—that is, incorporation of oxygen in the substance of the asphaltum—had taken place. As, therefore, an oxidation of the asphaltum by the agency of light cannot very well be predicated, there remains almost no other explanation than that by the agency of light a molecular change has been operated in its components, by which its physical properties are changed. Of analogous examples of the action of light not a few are known; for instance, the change of anthracene into paranthracene by sunlight offers an example of a body which loses its solubility through the action of light and is converted into an isomorphous or polymorphous body, and behaves quite differently with chemical reagents from what it did before. The above example is especially applicable in this case, as by heating to its melting point paranthracene is reconverted into anthracene and regains its solubility; in the same way, the *asphaltum which has become insoluble* again becomes soluble when heated to fusion.

"It is further known that under the action of light, when air is completely excluded, the formation of colored resinous substances, forming carbureted hydrogen, takes place in commercial petroleum, and that such formations are accelerated and intensified by the action of direct sunlight. Whether or no the formation of such resinous substances in petroleum is not connected with the sulphur it contains,† even though that should be very small in quantity, must remain unanswered for the present.

"The action of light upon asphaltum, with regard to its components, is not confined to thin films freed from their solvent, but extends to the same while still remaining in solution. Supposing a well closed white glass vessel, filled with a moderately concentrated filtered solution of asphaltum in oil of turpentine, or with a filtered ethereal extract, or only with the part insoluble in ether dissolved in oil of turpentine or chloroform, to be exposed for some time to sunlight: in every case there will be resinous precipitates which will have lost their solubility in their respective solvents. The greater part of this precipitate adheres fast to the sides of the vessel; a smaller portion remains suspended in the solution. Solutions of asphaltum or of its component parts should, therefore, be stored in the dark, since the precipitate (especially the part held in suspension) must have an injurious effect on its photographic employment.

"As the examination of the asphaltum from Syria and Trinidad has shown that it consists of at least three differently composed forms of sulphureted carburet of hydrogen, the next thing to discover was whether the photographic properties of the asphaltum belonged to the three components collectively, or only to certain individual components. The solution of this problem was also sought for experimentally, in a way similar to that already described. For this purpose solutions were prepared of the three isolated components of both Syrian and Trinidad asphaltum, five parts of weight of each being dissolved in 200 parts by weight of chloroform, and glass plates were coated with the solutions and treated as already described.

"After a three hours' exposure to the light of the sun the asphalted glass plates were taken into a dark room and treated with the already mentioned mixture of oils (oil of turpentine two parts, olive oil one part), the plates being several times coated with it, and then left for a few minutes to allow it to act. The solvent was now allowed to run off and then washed with petroleum ether.

"In the case of the substance soluble in alcohol no change was observable in the oily coating, and it had retained its perfect solubility. The substance soluble in ether had only partially and incompletely dissolved. The film of the substance insoluble both in ether and alcohol remained undissolved, even after the solvent had been allowed to act upon it for a long time.

"*From this experiment it follows that the property of sensitiveness to light belongs to the substance soluble in ether and to the insoluble substance, and that the property is present in the highest degree in the substance which is insoluble in ether and which is present in both sorts of asphaltum with the composition* $C_{21}H_{12}S_2$.

"It follows, further, that as the quantitative proportion of the individual components varies in the different sorts, the asphaltum which contains the largest proportion of the substance, $C_{21}H_{12}S_2$, will be the most sensitive to light, and as Syrian asphaltum contains fifty-two per cent. of it, and the Trinidad only thirty-eight per cent., the former must be regarded as the more sensitive of the two—a conclusion which finds a practical confirmation, as if two glass plates (one coated with Trinidad and the other with Syrian asphaltum) be exposed to light, and their behavior towards the solvent oils tested at short intervals, it will always be found that the plate coated with Syrian asphaltum shows insolubility even while the other is still soluble. Based on the foregoing observations Syrian asphaltum would appear to be the most suitable for photographic use, if in future it is not thought advisable first to eliminate, by treatment with ether, the substances soluble in alcohol and in ether, so as to employ exclusively those components which possess the greatest sensitiveness to light."—*Photographische Mittheilungen.*

* The analyses of Syrian and Trinidad asphaltum and the elementary composition of these asphalts as given above, are taken from Dr. Kayser's pamphlet by the *Correspondenz*, and inserted here as tending to make the article from the *Mittheilungen* clearer.

† Muspratt's "Chemistry," Kerl and Lohmann's edition.

PICTET'S CALORIFIC SYNTHESES.

PICTET modifies Mossotti's hypothesis, by supposing that atoms attract each other as well as attracting ether. He regards the gaseous atom as simple, the liquid molecule as composed of at least two gaseous atoms, and the solid molecule as containing at least two liquid molecules. Starting from the amplitude of calorific oscillation, he explains, by simple mechanical laws, the law of Mariotte and Gay Lussac, the anomalies with their limits and the conditions of passage from the gaseous to the liquid state, the mobility of liquids, their feeble compressibility, their diffusion and volatilization; the rigidity, elasticity, hardness, axes of crystallization, allotropism and amorphism of solids; the absolute zero temperature, thermic equilibrium and specific heat of bodies; the law of Dulong and Petit; fusion, evaporation, latent heat, density, vapor-tension, and nearly all the phenomena of thermo-chemistry. He thinks it probable that the dimensions of atoms and molecules may be deduced from his experiments.—*Bull. de la Soc. Vaud.*

ON A NEW HYDRIDE OF SILICIUM.

By M. J. OGIER.

1. I HAVE submitted pure siliciureted hydrogen to the action of the electric effluvium.* After a sufficient time this gas is entirely destroyed; a yellow coating is formed in the interior of the tubes, and the volume of the gas increases up to an apparently constant limit.

2. The residual gas does not contain a trace of silicium, but it is simply pure hydrogen.

The ratios between the volumes of the siliciureted hydrogen used, and the hydrogen resulting from its decomposition, have been found in five different experiments to be:

$$\frac{1}{1{\cdot}21}, \quad \frac{1}{1{\cdot}22}, \quad \frac{1}{1{\cdot}21}, \quad \frac{1}{1{\cdot}29}, \quad \frac{1}{1{\cdot}26}.$$

From these results it is easy to find the composition of the solid which was left on the glass, which contains the remainder of the hydrogen, united with all the silicium. In this way we arrive at the following formulæ (Si = 28):

$$SiH^{1{\cdot}58}, \quad SiH^{1{\cdot}56}, \quad SiH^{1{\cdot}59}, \quad SiH^{1{\cdot}43}, \quad SiH^{1{\cdot}48}.$$

These figures answer very nearly to the composition of Si_3H_2. The body under examination will, therefore, be a subhydride of silicium, corresponding to the suboxide of carbon, or again to crotonylene, in the series of carbureted gases.

3. Some of the properties of this body are as follows: When moderately heated in air it burns, throwing off small sparks. The combustion takes place spontaneously when hit with a hard body, or when rubbed with a steel blade. This subhydride is inflammable in chlorine when cold. When heated cautiously in an atmosphere of hydrogen or nitrogen, it evolves siliciureted hydrogen, easily recognized by its spontaneous inflammation in the air; a higher temperature only causes a deposit of silicium with the evolution of hydrogen.

4. We have seen that the electric effluvium at a high tension produces effects on siliciureted hydrogen, analogous to those which it produces on formene (the formation of acetylene, and a condensed carbide having a smell like turpentine, according to M. Berthelot). The analogy rests, if we study the fixation of nitrogen, by the effluvium on the siliciureted gas. In fact, a mixture of equal volumes of nitrogen and siliciureted hydrogen gave after the action of the effluvium a residual gas, consisting of hydrogen, nitrogen, and ammonia, which latter was easily detected by means of hydrochloric acid; but the ammonia was present in a very minute quantity, in fact it was hardly one per cent. of the residue.

On the other hand, the solid matter had equally absorbed a small quantity of nitrogen, which was evolved as ammonia by means of melting potash. This is exactly what was observed when the mixture of formene and nitrogen was submitted to the action of the electric effluvium.

5. I have experimented to see if any analogous hydride would be produced when siliciureted hydrogen is carefully heated. This gas is almost as stable as the corresponding carbides of hydrogen, for it will stand a temperature of nearly 400° before beginning to decompose. Keeping it at this temperature, I observed after a quarter of an hour a decomposition of more than 10 per cent.; after an hour the destruction was almost complete. Thus the silicic ether hydrogen resolves itself, purely and simply, into silicium and hydrogen without forming any intermediate hydrides as the carbides of hydrogen do.

6. I have similarly studied the action of the effluvium on arseniureted hydrogen; it also forms a solid hydride As_3H, corresponding to the solid phosphide of hydrogen, P_3H.*—*Comptes Rendus.*

* In the pipettes described by M. Berthelot (*Annales de Chimie et de Physique*, 5th series, vol. x., p. 76), in which the gas can be very easily introduced, taken out, and measured over mercury.

STARCH AND ITS TRANSFORMATIONS.

By H. T. BROWN and J. HERON.

AFTER a survey of the results obtained by former experimentalists, the authors describe the methods they have used for the purification of starch, for the preparation of starch-paste, and the preparation and analysis of the extract of malt, and the analysis of the transformation products of starch. They then examine the behavior of starch, with the extract of malt, after a preliminary notice of the changes undergone by a cold infusion of the latter, its fermentation in the cold, and its behavior when heated. They find that the invertive action of the malt ferment is most powerful about 55°, and ceases to act almost entirely at 60°. They then turn to the nature and properties of starch and starch cellulose, and the separation of a second body. They treat of the different glutinosity of starch paste as occasioned by very slight differences in the manufacture of the starch. They describe the sp. gr. of starch in the form of paste, the solubility of granulose, the optical activity of starch-paste, its behavior with potassa; the properties of maltose, its reaction with dilute sulphuric acid and with extract of malt, the behavior of the latter with starch, distinguishing the various kinds of grain; the action of extract of malt upon bruised starch, upon starch paste in the cold, describing the reaction as rapid and energetic; the behavior of malt extract upon starch paste in heat at a number of specified temperatures. They then treat of the detection of soluble starch or achroodextrin in presence of erythrodextrin; the influence of neutralization upon the activity of extract of malt, the molecular transformations of starch. They examine if dextrose is a product of the action of malt-extract upon starch, and reply in the negative, the product formed being maltose. Finally they discuss the nature of diastase.

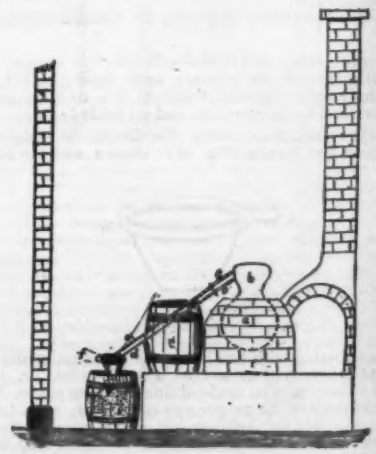
CERTAIN ULTRAMARINE COMPOUNDS.

By K. HEUMANN.

THE author concludes that in a successful operation in a sealed tube, the reaction of silver nitrate upon blue sodium ultramarine is a very complete substitution of the sodium by an equivalent weight of silver, the subsidiary reactions being so trifling that they may be overlooked. The yellow silver ultramarine is beyond doubt a silver compound, corresponding to the blue sodium ultramarine. The author considers that a quantitative study of the various reactions of silver ultramarine will be of great value for throwing a light on the nature of the ultramarine compounds.

OIL OF TURPENTINE FROM PINE CONES.

IN some districts of Thuringia, Germany, it has been customary for a long time to utilize pine cones for the preparation of oil of turpentine. The pine cones are sold by the forest officials on account of government, and are collected by gathering from the trees before they are completely ripe. They are then stored in flat sheds, lightly covered with brush, for three to five months, until they have become thoroughly loose. The apparatus used for distilling the oil of turpentine consists of a kettle, *a*, set in brick, surmounted by a tight fitting copper head, *b*, from which two tinned iron tubes, *c c*, about the caliber of rifle tubes, project downward, and are



joined to similar tubes passing upward through the condensing barrel, *e*, and meeting them. The condensed liquid runs through a funnel, *f*, into the glass globe, *g*, which has an opening at the lower end, closed with a stopper, and floats in the water contained in the barrel, *h*. The operations are begun by washing in a wooden trough with wooden stamps as many pine cones as may be introduced into the kettle, together with ½ to ⅓ of their volume of water. The addition of the latter is regulated by the degree of dryness of the cones. In the course of about twelve hours the distillation is completed.—*Indust. Bl.*

PLATINO-POTASSIC CHLORIDE.

By Dr. H. PRECHT.

THE author treats, in the first place, of the preparation of platinum chloride from residues. The concentrated alcoholic solutions are reduced, at a boiling temperature, by a mixture of soda solution and glycerin. Platino-potassic chloride is also completely reduced if gradually added to the boiling mixture, and if sufficient sodium carbonate is present. The precipitate of platinum-black is washed by decantation in a porcelain capsule till all sulphuric

* This research was carried on in M. Berthelot's laboratory at the College de France.

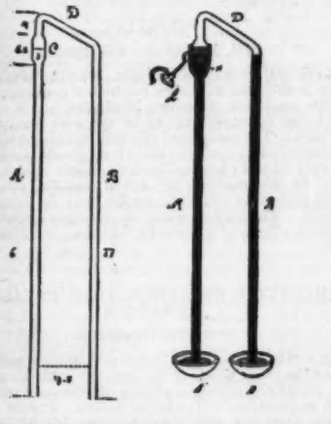
acid and potassium are eliminated, dried, ignited, and digested at a gentle heat in hydrochloric acid, to which sufficient nitric acid is gradually added. The solution is evaporated down at a gentle heat; the platinous chloride is converted into platinic chloride by the addition of fuming hydrochloric acid and a little nitric acid; the excess of the latter is expelled by the repeated addition of water and hydrochloric acid, and evaporation. The presence of platinous chloride is detrimental for the determination of potassium, rendering the results too high, while nitric acid occasions an error in the contrary direction. Traces of iridium have little effect on the accuracy of the analysis. Precht gives the solubility of platino-potassic chloride in alcohol as 1 part in 42,600 absolute, 1 part in 37,300 at 96 per cent., and 1 in 26,400 at 80 per cent. Platino-sodic chloride is soluble in boiling water in almost every proportion. Platinobaric chloride has the important property of being more or less completely decomposed into platinum chloride and barium chloride. Precht conducts the determination of potassium as follows: The sulphuric acid is removed by barium chloride in a solution containing 0·5 of hydrochloric acid to 1 of the salt. The clear liquid should contain neither barium chloride nor sulphuric acid. Traces of the latter may be removed in the measuring vessel by finely pulverized barium chloride. Small quantities of sulphuric acid are admissible if the solution with platinum chloride is not evaporated quite to dryness In acid solutions the objection to the removal of sulphuric acid by means of barium chloride—*i.e.*, that alkalies are carried down along with the barium sulphate—has little foundation. In neutral solutions so much potassium sulphate is thrown down that an error of 1 per cent. may be occasioned. In evaporating down with platinum chloride care should be taken that large crystals of platino-sodic chloride are not formed, which would interfere with washing. The latter process is best performed with hot alcohol, there being no danger of the reduction of $PtCl_4$.

A mixture of alcohol and ether is not to be recommended, but an addition of glycerine. For the determination of small quantities of potassium chloride along with an excess of sodium chloride, Precht evaporates 10 to 100 grms. along with a solution of platino-sodic chloride of known strength. The potassic salts are thus thrown down, the excess of the sodium compound is washed away with absolute alcohol, the platinum reduced on the filter, and weighed.—*Zeitsch. Anal. Chemie.*

HOW TO DISTILL MERCURY.

DR. LEONHARD WEBER describes an apparatus which may be used for purifying impure mercury, and which works almost automatically and is quite inexpensive.

A glass tube, bent and shaped in the manner indicated in the cut, and of the dimensions there given—the figures mean centimeters—is at first filled with pure mercury. The ends being now closed, the apparatus is inverted, the open ends immersed into two capsules, *s* and *s*, and the whole firmly fixed in a retort stand. The upper portion of the apparatus will now show a vacuum, and, as will be noticed, this portion of the apparatus will resemble in shape a retort, with



an open tube at the bottom, and a very long neck. The bulb, C, is now surrounded with the wire-gauge net, *n*, and a very small flame from a Bunsen burner applied to the upper portion of the mercurial layer. This will gradually volatilize the mercury, which condenses in the other limb. The mercury in the capsule, *s*, is gradually replaced by the stock of impure mercury to be purified, and pure metal now and then removed from the other capsule, until all the impure stock is used up. The quantity which may be distilled in twenty-four hours is about two kilogrammes.—*Carl's Rep. f. Exp. Phys.*

CEMENT WHICH RESISTS ACIDS.

MELT together carefully 1 part of caoutchouc (India-rubber) with 2 parts of linseed oil, and gradually incorporate with it 3 parts of white bole, so as to form a plastic mass.

This cement is not at all attacked by hydrochloric, and but very little by nitric acid. When heated it softens but very little. It does not easily dry upon the surface. If this cement is mixed with one-fifth of its weight of litharge or minium, it dries up in the course of time, and becomes hard. This is known as Benicke's cement.—*New Remedies.*

RESEARCHES ON NITRIFICATION.

By MM. SCHLOESING and MUNTZ.

NITRIFICATION is effected within well-marked limits of temperature. Below 5° it is exceedingly feeble, if not entirely annulled, becomes appreciable at 12°, reaches its maximum at 37°, and then declines. At 45° the formation is less than at 18°, and above 55° there is no longer a trace. Nitrification increases with the proportion of the moisture, so long as the free circulation of air among the particles of the soil or other medium is not arrested. A slightly alkaline state of the medium is also necessary, due generally in nature to the presence of the bicarbonate of lime. Alkaline carbonates have the same effect if very dilute, but if they exceed 2 or 3 parts in the thousand they become unfavorable and even arrest nitrification. The presence of small quantities of neutral salts of the alkalies or alkaline earths appears to have no influence. Organic substances seem to act by affording a carbonaceous pabulum for the nitric ferment. The formation of nitrites is frequent in a liquid medium, especially if the thickness of the stratum exceeds 2 mm. In soils nitrites are rarely produced.

HOW TO DETERMINE THE SPECIFIC GRAVITY OF LIQUIDS.

DR. LEONHARD WEBER recommends the following apparatus and process: Bend two glass tubes of as nearly as possible the same caliber, in the manner shown in the cut, and connect the lower ends by means of a rubber tube. Then fasten both tubes close to each other in a perpendicular position by means of a retort stand. Now pour a small quantity of each of the liquids to be compared with each other into the open ends, for instance, water into A and alcohol into B, until the lower bend is filled, then gradually add, alter-

nately to A and to B, more of the respective liquids. The columns of liquid in each tube will thereby rise more or less, but the compressed air retained in the connecting tube below will permit only a very slight rise of the liquids in the short limbs. The difference of level of the liquids in A and B are inversely proportional to the specific gravities of the liquids. If, therefore, the spec. gr. of one liquid is known, that of the other may readily be determined by measuring.—*Carl's Repert. d. Exp. Phys.*

RED AND BLUE LIGHT FROM GOLD.

PROF. ROSCOE lately exhibited the different preparations of gold in minute division made by Faraday himself, some of which transmitted blue light, and others red; showing that, at all events, two cases of molecular condition exist in the case of metallic gold.

A DEVICE FOR THE RAPID FILTRATION OF THE CARBON IN CAST IRON AND STEEL ANALYSES.

IN the analysis of cast iron and steel, much time is consumed in the separation of the carbon by filtration. Even under the most favorable circumstances the operation requires several hours. All attempts at rapid filtration by Bunsen's method, using the usual asbestos filter, proved unsuccessful. The increased pressure either forced the plug of asbestos through the funnel, or if the asbestos was more closely packed, the filtration was rendered exceedingly slow. In order to overcome this defect, if possible, a piece of apparatus was constructed, which seems to fulfill all the requirements very successfully.

A piece of platinum foil about 0·01 mm. in thickness, is cut into a disk, having very near the same diameter as the funnel used, which latter is of the same kind ordinarily used in the estimation of carbon. This disk (Fig. 1) is perforated with five or six holes, about 1 mm. in diameter, and to its center at right angles to its plane is soldered, with a minute piece of gold, a stout platinum wire about 1 mm. in diameter, and of such a length that it may extend a short distance below the contracted portion of the funnel (Fig. 2). When

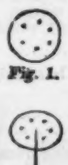


Fig. 1.

FIG. 2.

FIG. 3.

the disk is in position, the wire extends down through the smaller portion of the funnel, and tends to keep the platinum plate always horizontal (Fig. 3). Upon this plate is placed a thin layer of pure asbestos. The lower portion of the funnel may be placed through the cork of the receiver of a Bunsen pump, or any other convenient aspirator, as in the usual method of rapid filtration.

The asbestos should be moistened, and the pump set in action before the filtration commences, in order that the asbestos may become well packed before the finely divided precipitate is thrown upon it.

After the operation is finished, and the precipitate well washed, the pump should be allowed to run for a few minutes in order that the precipitate may become comparatively dry. In the state in which the carbon now remains, it may be pushed out of the funnel in a solid coherent cake, by pressure applied to the projecting platinum wire. The tube only requires to be wiped with a small piece of asbestos to render it perfectly clean from the adhering precipitate.

With this apparatus a filtration which, under ordinary circumstances, would occupy several hours, requires but from twenty minutes to half an hour for its completion.

J. CREAGH SMITH.

University of Pennsylvania, Nov., 1879.

SOME THOUGHTS ON THE TREATMENT OF DISEASE.

By JAMES G. CLARK, M.D., West New Brighton, Staten Island, N. Y.

I AM fully persuaded that a radical improvement in several respects will take place in the treatment of disease, and that those maladies heretofore so stubborn and almost beyond the reach of remedies will, most of them, if not all, be brought much more within the control of remedial measures. These conclusions are not the result of mere theorizing, but are founded upon experience and large facilities for observation. I have been a practitioner of medicine for over thirty-five years, and for twenty-five years did as large a general practice as perhaps any man in the State; attended several large hotels; for ten years the Home for Orphan Children of Seamen, and other public institutions. In these years have seen and treated a great amount and variety of disease, and am free to confess that I have often mourned (as doubtless every conscientious physician of extensive experience has) over the inefficiency of treatment in many cases, and that, too, after having been aided by the most skillful experts within my command. For the past few years have spent a good deal of time in visiting the medical men and hospitals of many of the capitals of Europe; and the more I see of the methods of managing disease, the more convinced am I of the room for improvement, and that better results should be reached.

The diseases afflicting the human family arise from various causes. Some from poisonous inhalations, many from congestions and inflammations. Some from the ingestion of deleterious substances, and some again from actual contact with disease, etc., etc. In all these there are more or less alteration and vitiation of the vital fluid and derangement of the circulation. Nature, in her efforts to relieve the system, endeavors to throw off the deleterious elements mostly by the skin. The skin, therefore, is one of the most important tissues of the body—perhaps the most important. Is more highly endowed with nerves and blood vessels than any other, and, as more than half of all that goes into the body passes off by the skin, it will be seen at once that it is a most important, if not the most important, depurating and eliminating organ of the blood organism. To keep the skin in a healthy condition and have it perform its functions physiologically is of the greatest importance. To assist it in eliminating the deleterious elements in disease should be the continuous effort of the physician.

THE VACUUM TREATMENT.

To aid in accomplishing this, I have contrived an air-tight receptacle that will contain the patient, from the cervical region, in the recumbent position. To this is attached an air pump; by which the desired quantity of air (as indicated by a gauge) may be pumped from within—the effect upon the surface of the patient being watched through two little glass windows, one opposite the chest, the other the lower part of the lower extremities. There is also an opening in the receptacle through which steam or medicated vapor may be introduced. The effect upon the body, when placed in this partial vacuum, will be readily understood by every one—viz.: that the atmospheric pressure being removed to the desired extent, the blood rushes to the surface, the cutaneous capillaries become distended, and the surface glowing, internal congestions and inflammations are relieved; poisonous elements circulating in the deeper vessels, disturbing the nervous centers, and impairing the functions of the viscera, are brought to the periphery and thrown off by the pores of the skin, which have been previously opened by cleansing, refreshing, and purifying washes (which remove the epithelial *débris*), and then treated by appropriate medicinal preparations, which readily find their way into the capillaries, and go bounding along with the circulation, neutralizing and rendering innocuous whatever is hurtful to the organism.

Take a case of double pneumonia (a disease that for the past few years has been so fatal in New York City), where the patient can hardly breathe from the pressure of the engorged blood vessels upon the delicate air vesicles and capillary bronchial tubes, and is being rapidly poisoned by the circulation of unaerated blood—can a more powerful method be conceived of for drawing away the blood and unloading these pulmonary vessels, than by placing the body in this vacuum receptacle and diverting the circulation to the surface, when the lung tissue, being relieved from pressure, air can be admitted, and medicaments and oxygen by inhalation? What, think you, are the chances for the patient thus relieved, as compared with his chances under the ordinary treatment?

The poison of scarlet fever is so deadly sometimes that it will destroy life in twenty-four or thirty-six hours. This I have seen more than once, and mourned over the helplessness of our art to save the beautiful child. Here, again, what could so powerfully and certainly bring the blood to the surface and expel the poison through the proper outlets?

Take paralysis dependent upon a clot in the brain; what process could so quickly and surely lessen the pressure and hasten the absorption of the clot as this?

Take typhus or typhoid fever, or the typhoid stage that any disease may run into, or the various forms of nervous affections so prevalent just now, dependent mostly upon engorgement about the nervous centers, causing cold hands and feet, and a morbid sensitiveness to low temperatures; or take chills and fever (the curse of so many localities), the essential conditions of the chill being a small, hard pulse, peripheral anæmia, and convulsive muscular contractions, caused by a congested condition of the deeper blood vessels containing more or less malarial poison acting upon the nervous centers—and does not this treatment present itself as foremost and infinitely superior to the large deafening doses of quinine, or the new and lately more fashionable, but dangerous remedy, pilocarpin, which relaxes arterial tension, causes a determination of blood to the surface, and, by the diaphoresis induced by it, brings about muscular relaxation—all which the vacuum receptacle will do with more certainty and without danger. I might go on in this way for an indefinite time, but am persuaded that the simplicity, efficiency, and practicability of this form of treatment are apparent to every man who will reflect a moment, and must be admitted by all.

THE ABSORPTION PLAN.

The readiness with which absorption takes place through the skin is well shown by the following case, as also the efficacy of medication by the surface. Some fifteen years ago, a baby three months old, suffering from cholera infantum and attenuated to the last degree, was brought from the city to the Latourette House, Bergen Point, and came into my hands. Its intra-uterine life had been six and a half months. This was well attested. The little creature was ejecting everything given it; and what to do, at first, was a puzzle—but something must be done, for all the ladies in the house had fallen in love with the little handful of humanity, and if the whole world had contained but this one baby the mother could not have been more anxious for its recovery. So we enveloped it in nice, soft, juicy beefsteaks, renewing them as often as the heat of the weather rendered necessary, preceding their application by a very delicate medicinal solution—giving by the mouth almost nothing—and thus we went on day by day.

The babe recovered, grew strong and well, and four years afterward became again my patient at Peteler's Hotel (now St. Mark's) for a bad scald of the chest, which she went through as bravely as if she'd been born at full term and had not had her life saved by beefsteaks externally applied. Another case forcibly illustrating the rapidity with which absorption takes place is given by Sir G. Hill: "A jockey had been for some time in training for a race, in which that gentleman was much interested, and had been reduced to the proper weight. On the morning of the trial, being much oppressed by thirst, he took one cup of tea; and shortly afterward his weight was found to have increased six pounds, so that he was incapacitated for riding. At least three-fourths of this increase was from cutaneous absorption, which function was suddenly stimulated by the cup of tea." I might give many more cases similar to that of the babe's in my own practice, perhaps not quite so marked, but where the result was quite as favorable—fully demonstrating the efficacy and efficiency of peripheral medication and sustentation.

THE INHALATION PLAN.

Along with this form of treatment by the surface, goes admirably well the introduction of medicaments into the circulation by inhalation. This is a very easy and very powerful way of combating disease. As it is through the air-passages that many pernicious elements enter the system, it would seem very natural that by the same ingress the correctives and antidotes should be sent; and all know how efficiently agents act given this way—as chloroform, nitrous oxide gas, oxygen, etc.

In many diseases, as typhus and typhoid fever, and the typhoid stage of other diseases, the tongue and mucous membrane become hard, rough, and as dry as a chip. The lining of the stomach is mostly in the same condition (for the tongue is the mirror of the stomach), and medicines placed in it are of no avail, for there is no action, no absorption, and they lie there dead and inactive. Now, you might as well place a weasel in a tightly cemented room from which there is no point of exit, and expect it to rid the house of rats, as to expect medicines placed in the stomach under these circumstances to have any controlling or curative influence over disease; and yet this is just what is done over and over again, indeed all the time, by physicians of every school everywhere. Not so do medicines act when given by inhalation; for, carried to the delicate vesicular membrane in thorough solution, they quickly enter the circulation, and, unimpeded by any action of the gastric juice, commence their neutralizing and curative work at once, and if properly and judiciously administered in conjunction with the use of the vacuum receptacle, and proper applications to the surface, I am sure that many diseases that are now the opprobrium of the profession will be rendered much more amenable to treatment. Of course there are many affections that readily yield to treatment by the stomach. Indeed, I believe that one-half of all the ailments to which humanity is liable may be controlled by the "*vis medicatrix naturæ*" alone, and would get well without any treatment further than the proper regulation of diet and exercise.

I do conscientiously believe that by the inhalation of medicaments, carefully prepared and judiciously administered—by the application of medicaments, carefully prepared and properly applied, after the skin has been well cleansed (all dead epithelium being removed), together with the use of the receptacle, a new era in the treatment of disease will be inaugurated, and a success attained in the curing of the graver maladies that will surpass anything yet realized.

It has often occurred to me that the importance of atmospheric pressure, as affecting the health and general condition of mankind, is not sufficiently estimated. I believe with a celebrated writer, who said: "Give me the physical aspect of the country, and I'll give you the character of the inhabitants." And he might have added, the physical development also. All know that elevated situations for habitations are much healthier than those in the valley or low places. Some will say because the air is purer, and in this they are correct so far as they go; but it is well known that as we ascend, the atmospheric pressure lessens, and if we go high enough this will be unpleasantly demonstrated by blood issuing from parts of the body. When a suitable elevation is reached, the peripheral circulation is much increased; the action of the lungs is freer and fuller, and a feeling of exhilaration is experienced from the improved oxygenation of the blood. Therefore, how infinitely better it would be for the health of the denizens of cities to pass their summers among the mountains, than at the crowded places of fashionable resort! What a marked improvement there would be, not only in their physical, but mental condition (to say nothing of morals), in the course of two or three years' living rationally, exercising judiciously in the fine, exhilarating mountain air! One of my patients, who suffered much from asthma, spent a winter at the Fifth Avenue Hotel. After a little he discovered that he could live much more comfortably, with much less dyspnœa, on the fifth floor than any lower down—and here, of course, he fixed his quarters. With the lessening of the surface pressure his peripheral capillary circulation was increased, and his lungs correspondingly relieved. How large a number of persons suffering from lung trouble have been greatly benefited by living in the Adirondacks! One occasionally being obliged to remain there throughout the winter, as was the case with a physician of some note, who, while remaining in those mountains, enjoyed fair health, but each time on coming to the city and remaining a short time, would have hemorrhages, night sweats, and all the symptoms of rapid tuberculosis, rendering his flight to the mountains and remaining there imperative.

CURES BY ELECTRICITY.

Then, again, there are some affections in which all remedies by the stomach are at times wholly inefficacious, even when that organ is in good working condition. I remember a striking case of this sort in a young lady suffering from ovarian neuralgia, which came on regularly every morning, and was very severe. I used everything in the way of anti-periodics, anodynes, counter-irritants, etc., that I thought applicable to the case, but with no apparent permanent good result. The father, tired of seeing his child suffering so, took her to a famous homeopath in the city, and he encouraged them greatly by saying that the trouble was not ovarian but in the kidney, and that he'd make short work of it; but he was longer at the case than I was, and no more successful—when the electro-chemical baths were suggested, the first one of which brought entire relief. I had at one of the hotels a somewhat similar and severe case, in the management of which were associated with me three of the best physicians from the city, and in this case, too, medicines had only a very slight temporary effect. The cure was effected quickly and permanently on the ninth day by electricity. While I think this treatment applicable in most cases, it is more particularly so in those of internal congestions and inflammations, in eruptive and congestive fevers, and impaired circulation.

KEEP THE SKIN IN GOOD CONDITION.

Doubtless the importance and benefit of keeping the skin of animals in good condition is patent to all, for no animal will thrive and do well unless this be the case.

For many years I have been a strong advocate for the clipping of horses, and invariably have it done every winter on every horse whose hair is too long and thick to admit freely of the brush and curry-comb reaching the skin. Some years ago I had a horse who threw out early in the fall a very thick, heavy coat. Soon the legs began to swell, which increased daily, notwithstanding the giving of purgatives, diuretics, and free rubbing, all of which were resorted to, as I did not want to clip so early; but all of no avail. The horse was clipped. A greasy scum all over his skin (which the comb and brush could not reach) was removed by a wash of whisky, water, and borax; and now, after a drive all swelling was gone, and did not return—and in eating, driving, and feeding he was a new horse.

Clipping the horse when the hair is coarse, thick, and long is the very best thing that can be done, for he will do a third more work on a third less feed, and is a merciful, and not a cruel procedure. I also recommend the clipping of cattle that are being fatted, where the hair is long and coarse, believing—indeed, knowing—that such cattle would fatten much easier, and the meat would be more tender and much sweeter.

In a word, I have long been impressed with the belief that not a tithe of the attention to the condition of the skin in disease, and what may be effected by medication and sustentation thereby, is given by physicians, and until this is done, the success that should be attained will not be reached.

True, Europe has its mud-baths, and Philadelphia its mud poultices; and we have Turkish baths and Russian baths, and all kinds of baths, and all are good as far as they go; but to our mind, repeated daily thorough cleansing of the skin by medicated washes, and the insuring a free peripheral capillary circulation, are the prime essentials in the treatment of disease.—*Medical Record.*

LIP-SALVE.*

Spermaceti	40 parts.
Lard, perfectly pure and fresh	80 "
White wax	20 "
Oil of sweet almonds	5 to 10 "

according to the season of the year, are melted together, the mixture colored with a sufficient quantity of alkanet, by digesting the root with the melted mass, and the latter then suitably perfumed, for instance, with

Oil bergamot	2 parts.
Oil orange	3 "

The mass is then poured out into moulds. It is customary to pour it into tin-tubes, from which it is removed when cold, and then covered with tin foil.

Cold Cream (Crême Celeste).

1. Spermaceti	30 parts,
White wax	24 "
Oil of sweet almonds	168 "

are melted together at a gentle heat, the melted mass poured into a warm porcelain or Wedgwood mortar, stirred until it begins to solidify, and then intimately mixed with

Rosewater	70 parts.

After stirring until cold, there may be added, for every 10 ounces of the mixture,

Oil of rose	2 drops.
Oil of bitter almonds	3–4 "

This cream is white. The following formula yields a cheaper, slightly yellow, but still very good product:

2. White wax	166 parts.
Olive oil, finest	500 "
Rosewater	100 "
Oil of bergamot	15 "
Oil of bitter almonds	q.s.

To be prepared as the preceding.

Glycerine Cream (Crême de Glycerine).

Spermaceti	60 parts.
White wax	30 "
Oil of sweet almonds	250 "
Rosewater	10 "
Glycerine	20 "

To be prepared like cold cream, and to be perfumed with oil of rose and oil of bitter almonds.

Almond Cream (Crême d'Amandes).

Lard, perfectly pure and fresh	220 parts.
Solution of potassa, containing 26 per cent. of caustic potash	120 "
Alcohol, 60 per cent.	10 "
Oil of bitter almonds	q.s.

Triturate, in a porcelain or Wedgwood mortar, the lard and potassa solution, and let it stand a few hours. Then add the alcohol and sufficient oil of bitter almonds to give it the proper flavor. Finally triturate until the mass is uniform, and resembles mother-of-pearl.

This cream has a handsome look, but is not so bland as the first mentioned varieties.

* From *New Remedies.*

A CATARRH CURE.

By HANS M. WILDER.

WHEN people get a cold on the chest, as they call it, among other good things are prescribed the wearing of a respirator when out of doors, and, when at home, balsamic inhalations or sprays.

I should think both things combined—a medicated respirator, so to call it—would be a decided improvement. Let the respirator be soaked or sprinkled with the same balsamic mixture which patients are ordered to use indoors as inhalation. When they use the respirator, prepared as above, away from home, the air which they inhale will always be charged with the vapors of the inhalation, although in a less degree, and in this way their air passages will be continuously under treatment and consequently recover so much the quicker.

I got this idea from personal experience. Having a heavy cold in the head, I got a bottle of Hager's olfactorium anticatarrhoicum (see below) with addition of a little essential oil of cubebs. This bottle I carried in my upper waistcoat pocket; the stopper came off and the contents were spilled on my clothes. Wearing the same clothes, I was constantly enveloped in a balsamic atmosphere, and got completely rid of my cold and accompanying hoarseness in four days; ordinarily it takes a couple of weeks.

Olfactorium anticatarrhoicum.

Acid carbol. pur	5 parts.
Alcohol	5 "
Aq. ammon	6 "
Aquæ	10 "

A few days after being mixed it turns bluish black (through formation of aniline) and acquires a more disagreeable odor; the best way to make it is to dissolve the carbolic acid in alcohol by itself in one bottle, and the diluted ammonia in another bottle. When using, pour from each bottle a few drops into a tumbler or cup, shut the eyes, and inhale the vapor through the nose and mouth; it is smarting at first, but one soon gets used to it. The quantity of the ammonia may, of course, be decreased.—*New Remedies.*

ANTISEPTIC DRESSING OF WOUNDS.

By MM. GOSSELIN and BERGERON.

THE authors ascribe the beneficial action of these dressings not merely to the destruction of ferments, but to the coagulation of the albumen.

POISONOUS PROPERTIES OF PHENOL.

By DR. BINNENDIJK.

THIS acid acts in a direct manner upon the cerebro-spinal nervous system, and especially upon the respiratory center, and is not without influence upon the blood. It is partly transformed in the organism, yielding hydroquinon, pyrocatechin, etc. A portion of the phenol seems to be oxidized.

VANILLIN.

MM. HAARMANN and REIMER.

AN ethereal extract of vanillin, whether obtained from vanilla pods or the oxidation product of coniferin, if shaken up with a solution of sodium bisulphite, yields up its vanillin to the latter, exactly as in the case with the other aldehydes. The compound of vanillin with the bisulphite is then destroyed by the addition of sulphuric acid, and the pure vanillin is withdrawn from the liquid by agitation with ether. In this manner the actual vanillin, either in the natural pods or in artificial samples, may be accurately determined. The authors maintain that their artificial vanillin is chemically and physically identical with the natural product.

COMPARATIVE RESEARCHES ON PTYALIN AND DIASTASE.

By TH. DEFRESNE.

THE action of the saliva is arrested by *pure* gastric juice; but, on the other hand, if we operate with mixed gastric juice, containing merely organic acids, the saccharification of starch proceeds as well as in the mouth. Ptyalin and diastase are, therefore, not physiologically identical, since the saccharifying action of the latter is irrecoverably destroyed by pure gastric juice or by hydrochloric solutions, and even after contact with mixed gastric juice, though it still dissolves starch, it no longer saccharifies.

THE METEOROGRAPH.

To the Editor of the Scientific American:

Will you, in the interest of the true history of scientific invention, refer to the files of the SCIENTIFIC AMERICAN for May, 1854, and see if you did not publish an account of essentially the same device for registering the direction of the wind, that is found in the SCIENTIFIC AMERICAN SUPPLEMENT for January 3, 1880, and credited to Dr. Draper?

A fuller account of a paper read before the American Scientific Association, at eighth meeting in Washington, 1854, may be found on page 224 of published proceedings of that meeting; also, there is a notice of the register in "Annual of Scientific Discovery" for 1855, page 193.

As the writer of this devised and constructed this part of Dr. Draper's ingenious set of automatic instruments more than a quarter of a century ago, and made it public by description and exhibition of its actual work to the American Scientific Association, he feels himself entitled to whatever credit is due as its originator, and fortunately his claim is easily established, unless some one can show its existence prior to April, 1854.

As several self-registering instruments were combined, a name was necessary, and the term "meteorograph" was used to designate the set of automatic registers. Can any one find the word *meteorograph* used prior to May, 1854?

Please refer as above and oblige

N. B. WEBSTER.

Webster Military Institute, Norfolk, Va.

[Note. We are glad to be able to place the claims of Prof. Webster so clearly before our readers. Dr. Draper, we believe, in presenting the drawings of his instruments, made no claim to the original authorship of this class of devices].

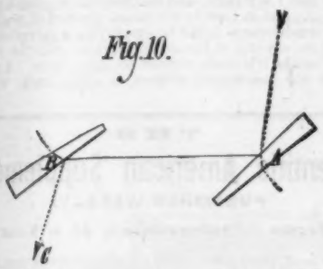
THE SUN.

By S. P. LANGLEY, Allegheny Observatory, Pa.*

WHEN, with a powerful telescope, we return to the study of the sun's surface, we meet a formidable difficulty which our first simple means did not present. This arises from the nearly constant tremors of our own atmosphere, through which we have to look. It is not that the tremor does not exist with the smaller instrument, but now our higher magnifying power exaggerates it, causes everything to appear unsteady and blurry, however good the glass, and makes the same kind of trouble for the eye which we should experience if we tried to read very fine print across the top of a hot stove, whence columns of tremulous air were rising. There is no remedy for this, unless it is assiduous watching and infinite patience, for in almost every day there will come one or more brief intervals, lasting sometimes minutes, sometimes only seconds, during which the air seems momentarily tranquil. We must be on the watch for hours, to seize these favorable moments, and, piecing together what we have seen in them, in the course of time we obtain such knowledge of the more curious features of the solar surface as we now possess.

The eye aches after gazing for a minute steadily at the full moon, and the sun's light is from 300,000 to 600,000 times brighter than full moon light, while its heat is in still greater proportion. The object lens of such a telescope as the equatorial at Allegheny is 13 inches in diameter, and it is such light and such heat, concentrated by it, that we have to gaze on. The best contrivance so far found for diminishing both, and without which our present acquaintance with the real appearance and character of sunspots would not have been gained, depends upon a curious property of light, discovered by a French physician, Malus, in the beginning of this century. Let A (Fig. 10) be a piece of plane unsilvered glass, receiving the solar rays and reflecting them to a second similar one, B, which itself reflects them again in the direction C. Of course, since the glass is transparent, most

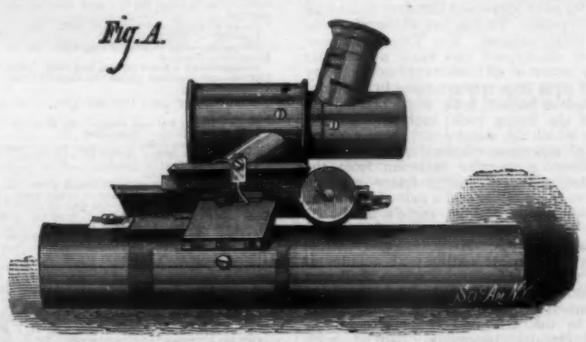
Fig. 10.



of the rays will pass through A, and not be reflected. Of those which reach B again most will pass through, so that a hundredth part of the original beam reaches C. This then, is so far a gain; but of itself of little use, since, such is the solar brilliancy, that even this small fraction would, to an eye at C, appear blindingly bright. Now, if we rotate B about the line joining it with A, keeping always the same reflecting angle with it, it might naturally be supposed that the light would merely be reflected in a new direction unchanged in quantity.

But according to the curious discovery of Malus this is not what happens. What does happen is that the second glass, after being given a quarter turn (though always kept at the same angle), seems to lose its power of reflection almost altogether. The light which comes from it now is diminished enormously, and yet nothing is distorted or displaced; everything is seen correctly if enough light remains to see it by at all, and the ray is said to have been "polarized by reflection." It would be out of place to enter here on the cause of the phenomenon; the fact is certain, and is a very precious one, for the astronomer can now diminish the sun's light till it is bearable by the weakest eye, without any distortion of what he is looking at, and without disturbing the natural tints by colored glasses. In practice, a third and sometimes a fourth reflector, each of a wedge shaped, optically plane piece of unsilvered glass, are thus introduced, and by a simple rotation of the last one the light is graded at pleasure, so that with such an instrument, called "the polarizing eyepiece" (Fig. A), I have often watched the sun's

Fig. A.



magnified image for four or five hours together with no more distress to the eye than in reading a newspaper.

With this, in favorable moments, we see that the sun's surface away from the spots, everywhere, is made up of hundreds of thousands of small, intensely brilliant bodies, that seem to be floating in a gray medium, which, though itself no doubt very bright, appears dark by comparison. What these little things are is still uncertain; whatever they are, they are the immediate principal source of the sun's light and heat. To get an idea of their size we must resort to some more delicate means of measurement than we used in the case of the watch. The filar micrometer consists essentially of two excessively fine strands of cobwebs (or, rather, of spider's cocoon), called technically "wires," stretched parallel to each other and placed just at the focus of the telescope. Suppose one of them to be fixed and the second to be movable (keeping always parallel to the first) by means of a screw, having perhaps one hundred threads to the inch, and a large drum-shaped head divided into one hundred equal parts, so that moving this head by one division carries the second "wire" $\frac{1}{10000}$ part of an inch nearer to the first. Motions smaller than this can clearly be registered, but it will be evident that everything here really depends upon the accuracy of the screw. The guide screw of the best lathe is a coarse piece of work by comparison with "micrometer" screws as now constructed (especially those for making the "gratings" to be described later), for recent uses of them demand perhaps the most accurate workmanship of anything in mechanics—the maker of one which will pass some lately invented tests is entitled at any rate to call himself "a workman."

Since the "wires" are stretched precisely in the focus, where the principal image of the sun is formed, and move in it, they, and the features of the surface, form one picture, as magnified by the eye lens, so that they appear as if moving about on the sun itself. We can first set them far enough apart, for instance, to take in the whole of a spot, and then by bringing them together measure its apparent diameter, in ten thousandths of an inch. Then, measuring the diameter of the whole sun, we have evidently the proportion that one bears to the other, and hence the means of easily calculating the real size. A powerful piece of clockwork, attached to the equatorial, keeps it slowly rotating on its axis, at the same angular rate as that with which the sun moves in the sky, so that any spot or other object there will seem to stay fixed with relation to the "wires," if we choose, all day long. The picture of "wires," spots, and all, may be projected on a screen if desired; and Fig. 11 shows the field

Fig. 11.

of view, with the micrometer wires lying across a "spot," so seen on the 6th of March, 1873. Part of a cambric needle with the end of a fine thread is represented also as being projected on the screen along with the "wires" to give a better idea of the delicacy of the latter.

Now we may measure, if we please, the size of one of those bright objects, which have just been spoken of as being countable by hundreds of thousands. These "little things" are then seen to be really of considerable size, measuring from one to three seconds of arc, so that (a second of arc here being over 400 miles) the average surface of each individual of these myriads is found to be considerably larger than Great Britain. Near the edge of the disk, under favorable circumstances, they appear to rise up through the obscuring atmosphere which darkens the limb, and gathered here and there in groups of hundreds, to form the white cloudlike patches (*facuIæ*), which may sometimes be seen even with a spy-glass—"something in the sun brighter than the sun itself," to employ the expression by which Huyghens described them nearly two hundred years ago. They are too minute and delicate objects to be rendered at all in our engraving; but this is true also of much of the detail to be seen at times in the spots themselves. The woodcuts make no pretense to do more than give an outline of the more prominent features, of which we are now about to speak.

The wonderful beauty of some of their details must be taken on trust, from the writer's imperfect description of what no pencil has ever yet rendered and what the photograph has not yet seized.

Bearing this in mind, let us now suppose that while using the polarizing eyepiece on the part of the spot distinguished by the little circle, we have one of those rare opportunities when we can, by the temporary steadiness of our tremulous atmosphere, use the higher powers of the telescope and magnify the little circle till it appears as in Fig 12. We have now nearly the same view as if we were brought close to the surface of the sun, and suspended over this part of the spot. All the faint outer shade, seen in the smaller views (the *penumbra*) is seen to be made up of long white filaments, twisted into curious ropelike forms, while the central part is like a great flame, ending in fiery spires. Over these hang what look like clouds, such as we sometimes see in our highest sky, but more transparent than the finest lace vail would be, and having not the "fleecy" look of our clouds, but the appearance of being filled with almost infinitely delicate threads of light. Perhaps the best idea of what is so hard to describe, because so unlike anything on earth, is got by supposing ourselves to look *through* successive vails of white lace, filled with flower-like patterns, at some great body of white flame beyond, while between the spires of the flame and separating it from the border are depths of shade passing into blackness. With all this, there is something crystalline about the appearance, which it is hard to render an idea of—frost figures on a window pane may help us as an image, though imperfect. In fact the intense whiteness of everything is oddly suggestive of some thing very cold, rather than very hot, as we know it really. I have had much the same impression when looking into the open mouth of a puddling furnace at the lumps of pure white iron, swimming half-melted in the grayer fluid about them.

Here, however, the temperature leaves nothing solid, nothing liquid even; the iron and other metals of which we know these spot forms do in part at least consist are turned into vapor by the inconceivable heat, and everything we are looking at consists probably of clouds of such vapor; for it is fluctuating and changing from one form into another while we look on. Forms as evanescent almost as those of sunset clouds, and far more beautiful in everything but color, are shifting before us, and here and there we see, or think we see, in the sweep of their curves beyond, evidences of mighty whirlwinds (greater by far than the largest terrestrial cyclone) at work. While we are looking, and trying to make the most of every moment, our atmosphere grows tremulous again, the shapes get confused, there is

Fig. 12.

nothing left distinct but such coarser features as our engraving shows, and the wonderful sight is over. When we consider that this little portion of the spot we have been looking at is larger than the North and South American continents together, and that we could yet see its parts change from minute to minute, it must be evident that the actual motion must have been rapid almost beyond conception—a speed of from 20 to 50 miles a *second* being commonly observed and sometimes exceeded. (A cannon ball moves less than ¼ of a mile per second.) I have seen a portion of the photosphere, or bright general surface of the sun, drawn into a spot, much as any floating thing would be drawn into a whirlpool, and then, though it occupied by measurement over 3,000,000 miles in area, completely break up and change so as to be unrecognizable in less than twenty minutes.

When we come to discuss the subject of the sun's heat, we shall find that the temperature of a blast furnace or of the oxyhydrogen blowpipe is low compared with that which obtains all over such a vast region, and remembering this, it is evident that its disappearance is a cataclysm of which the most tremendous volcanic outburst here gives no conception. We cannot, by any terrestrial comparison, describe it, for we have no comparison for it in human experience. If we try to picture such an effect on the earth, we may say in another's words that these solar whirlwinds are such as, "coming down upon us from the north, would in thirty seconds after they had crossed the St. Lawrence be in the Gulf of Mexico, carrying with them the whole surface of the continent in a mass, not simply of ruin, but of growing vapor, in which the vapors arising from the dissolution of the materials composing the cities of Boston, New York, and Chicago would be mixed in a single indistinguishable cloud."

These vast cavities then in the sun we call spots are not solid things, and not properly to be compared even to masses of slag or scoria swimming on a molten surface. They are rather rents in that bright cloud surface of the sun which we call the photosphere, and through which we look down to lower regions. Their shape may be very rudely likened to a funnel with sides at first slowly sloping (the *penumbra*), and then suddenly going down into the central darkness (the *umbra*). This central darkness has itself gradations of shade, and cloud forms may be seen there obscurely glowing with a reddish tinge far down its depths, but we never see to any solid bottom, and the hypothesis of a habitable sun far within the hot surface, suggested by Sir William Herschel, is now utterly abandoned. We are able now to explain in part that mysterious feature in the sun's rotation before insisted on, for if the sun be not a solid or a liquid, but a mass of glowing vapor, it is evidently possible that one part of it may turn faster than another. *Why* it so turns, we repeat, no one knows, but the fact that it does is now seen to bear the strongest testimony to the probable gaseous form of the sun throughout its mass—at any rate, to the gaseous or vaporous nature of everything we see. We must not forget, however, that under such enormous temperature and pressure as prevail there the conditions may be—in fact, must be—very different from any familiar to us here, so that when we speak of "clouds," and use like expressions, we are to be understood as implying rather an analogy than an exact resemblance.

We must expect, with the great advances photography has lately made, to know more of this part of our subject (which we may call solar meteorology) at the next spot maximum than ever before, and by that time it may be hoped that some of the wonderful forms described above so imperfectly will have been caught for us by the camera.

* Continued from SCIENTIFIC AMERICAN SUPPLEMENT, No. 214, page 3410.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

November 18, 1879.—J. P. JOULE, D. C. L., LL. D., F.R.S., etc., President, in the Chair.

THE president noticed the lamented death, since the last meeting, of Prof. James Clerk-Maxwell, an event which, having occurred in the prime of his life and in the midst of his usefulness and his splendid researches, was felt most severely by the society and the whole scientific world.

RECORDING SUNSHINE.

By DAVID WINSTANLEY, F.R.A.S.

So far as I have seen, there is in use at present but one form of apparatus which effects an automatic registration of the duration and the times of sunshine, and that is the instrument of Campbell, in which a sphere of glass is so disposed as to burn a piece of wood or paper by the concentration of his rays when the sun may chance to shine. During the past few years I have devoted some attention to this matter, and devised a number of appliances having the same object for their end, but differing materially both in their construction and in the manner of their use from the apparatus I have named.

One of these, with your permission, I will now describe.

It is an arrangement which places a lead pencil on a sheet of paper and writes down therewith when and for how long the sunshine lasts.

It consists essentially of a differential thermometer with a long horizontal stem, in which latter is contained, throughout the greater portion of its length, some fluid intended to operate by its weight. This thermometer is attached to a scale beam or some equivalent device, which also carries the pencil by means of which the record shall be made.

The whole is so arranged that in its normal state it rests gently—upon that side to which the pencil is *not* attached—on an embankment provided for that end.

Close beneath the pencil point a disk of metal rotated at the proper speed carries a paper dial whereon marks and figures are engraved corresponding with the hours at which the sun may shine.

When using this instrument I have it inclosed within a box which permits one bulb only of the thermometer—that most distant from the clock—to be affected by the radiance of the sun, which when it shines expands the air contained therein, forces the fluid along the tube, and by altering the equilibrium of the beam brings some portion of its weight to bear upon the pencil point, and so the record is commenced.

When the sun becomes obscured, the air expanded by his rays contracts, the fluid in the tube returns, the normal equilibrium is restored, and the pencil ceases to produce its mark.

In the instance of the instrument I use the stem of the thermometer is 18 inches long, and the eighth of an inch or thereabouts in bore.

Mercury, in consideration of its weight, is the fluid I employ, and in conjunction with it some sulphuric acid is inclosed, because of the mobility which is thereby gained. I am aware that in these circumstances mercuric sulphate is very slowly formed, but after two years' lapse of time no inconvenience has been caused thereby, and the mobility of the mercury remains.

The bulbs of the thermometer are 2 inches in diameter, or thereabouts; and that they may be more rapidly affected, the glass thereof is thin. Both are blacked, and the one intended to receive the radiance of the sun projects above the box in which the apparatus is contained into a dome of glass.

NEW ARCHÆOLOGICAL AND SCRIPTURAL DISCOVERIES IN PHŒNICIA.

WHEN, four years ago, it was announced that an unostentatious French expedition was about to explore and unearth the archæology of the land known in ancient times as Phœnicia, few expectations were formed of the result. And, indeed, the earlier reports were far from satisfying the enthusiasm that had been awakened. It was thought that, long ago, travelers ranging the Syrian coast had exhausted the sites and ruins of Sidon, Tyre, Biblos, and Aradus—to give them their classic names—everywhere and between Mount Carmel and the river Orontes. No desolate cities were discovered, no temples or antique inscriptions, little more than indistinguishable fragments and nameless graves. Where the Hittites and the Hivites had flourished, at the foot of Lebanon, scarcely any definite remains were found, though the history of the Canaanites, at all events, dated from the age of the latter Pharaohs. But the spirit of investigation was not discouraged, and abundant riches of discovery rewarded it. Not to wander into speculation concerning the conection between this Scripturally celebrated territory, and the monumental chronicles of old Egypt, it may be at once explained that these, the most recent researches, were aimed in four directions, in Aradus, Biblos, Sidon, and Tyre, the modern names of which are Ruad, Gebeil, Saida, and Tour. The first is an island, mentioned in the Book of Genesis, and was among the most venerable sanctuaries of Canaanites, and is little better than an isolated rock, sprinkled with habitations, separated by narrow alleys, exactly as in the time of Strabo. The buildings themselves are, in all likelihood, of no great antiquity, but they have preserved in many respects fashions which are among the oldest in the world. The inhabitants are Mohammedans at the present day, and bitterly opposed to all kinds of excavations on their soil. But the neighboring coasts and plains were too rich in relics to allow of the archæologists being daunted by a repulse more wordy than real. They came upon miles and miles of mouldering shrines and towns, now the hiding-places of brigands, or the refuges of persecuted sects; but the iconoclastic fury of the Turk, aided by fanaticism of a different description, had battered out of recognition the temples of Adonis and Baal alike; of all the columns lying on the ground—and these were to be counted by hundreds—not one was unmutilated, and that evidently by design. There is no example upon earth, says the writer who reports these facts to the Academy at Paris, of a more complete and deliberate destruction. Yet the story which these ruins might have told must have been of unparalleled interest to the world. They would have spoken, after the lapse of centuries, through an utter confusion of languages and races. Some among them, no doubt, as the mythical tomb of Adonis, the monument of Ghineh, representing his fate and the lamentations of Venus, and the sanctuary of Apollo, buried among rocks and pines, belong to a distinctly Pagan period; but the modern City of Saida, the historical Sidon, is constructed almost exclusively of mouldering materials, every stone of which is a relic, recalling "the first-born of Canaan." Still, very few of them are of much value from an archæological point of view; there is, for the most part, nothing upon them to decipher. Separated, indeed, from this garden and cemetery—two inexhaustible mines of small antique objects—Sidon affords few evidences of its Phœnician history. Four times leveled to the ground, it would indeed have been a marvel had this city retained any, even the least, of its original form and features. So again with Tyre. The modern town is the work, built from ruins by the Saracens and the Crusaders in turn. The French expedition sought in vain, however, for any remains capable of absolute identification with those of its magnificent temples, vast port, royal palaces, great arsenals, or even high-storied private houses. But they recorded it as their belief that in these antique cities the inhabitants were far more closely packed together, and piled up more loftily, than in either nineteenth century London or nineteenth-century Paris. They were cribbed within walls; pilgrims to the shrines were incessantly making inroads upon their space; they usually located themselves on the narrow heads of promontories jutting out into the sea, and thus the nature of their position determined in a considerable degree the character of their domestic as well as of their religious architecture.

Still, it was not with a view to these or similar generalities that the French Commission, on its first as in its latest venture, set to work. Its primary object was the discovery of objects of art and inscriptions which might have been preserved in these "cities of dust." Of Phœnician art, of course, there was never any in existence—that is, in the Egyptian, Greek, and Roman sense of the term. They were in the main a nation of utilitarians, but they borrowed a good many forms from the banks of the Nile not less than, in a later time, from Greece. The interest of the investigation consisted greatly, therefore, in the possibility of identifying and connecting in a direct chain these historical and traditional links. Nothing is more certain than that of the shrines of Adonis and Baal not a solitary trace was found. Those temples, in their second age of ruin, were the ruins of a Græco-Roman epoch; in fact, the Phœnicians were always copying, and in this circumstance is written a large chapter of their artistic and archæological history. Yet legends turned up in that country, so barren in art, of former splendors; of a shrine which might be compared with the celebrated one at Jerusalem; of stones and marbles, exquisitely quarried, of colossal pedestals, of bronze columns, with richly wrought capitals, of precious woods and plates, of beaten metals; but nothing of this was dug up from amid the "powdered past." Some explanation is attempted here. To the geology of Greece was due, we are told, some of her long-enduring glory in architecture and sculpture. The marbles of the Syrian coast, rough and granular, and exceedingly irregular, both in their hardness and their density, could never be so finely wrought or last so long as those from the Grecian quarries. This in part gave rise to the practice of hewing monoliths out of enormous rocky masses, imitating to some extent the excavated temples and palaces of more antique times. Thus the architect became subordinate to the material, and not the material to the architect. Huge ancient structures became, indeed, quarries for more modern builders to pillage, and fragments of Greek, Roman, Byzantine, Saracen, Templars, Hospitalers, and the Teutonic order are everywhere to be met with, though scarcely anywhere in a consistent form. They were all accustomed to plan their edifices on a Cyclopean scale. Yet, dating from a period even anterior to the Greek, some treasures linger, in Ruad especially; fragmentary pavements of alabaster, painted with figures of griffins and sphynxes; Egyptian statuettes covered with hieroglyphic inscriptions; basalt blocks, supposed to be the pedestals of pillars, also decorated with archaic symbols; ruins of gigantic walls, of irregularly-sized stones, admirably arranged one in harmony with another, held fast by no cement, and to all appearance not artificially hewn or chipped into form. It was, however, at Amrit, in the building styled by the people of the country, in distinction to every other, "The Temple," that the most perfect example of Phœnician architecture survives. Neither at Paphos nor at Malta, says the scholarly chief of the commission, does anything exist approaching to it. In the center of a vast quadrangular court, hollowed in the rock, rises on a solid square of stone a species of tabernacle, closed on three sides, with a mighty monolithic slab constituting its roof, and over-lapping in front, and bearing traces of what to all appearance were columns that assisted in supporting it. High benches ranged on either hand along the entire length of the chamber, square hollows in the wall, apertures which have been intended to hold candelabra, projecting bands of stone upon which may have been nailed or riveted plates of metal inscribed with religous precepts or the tables of the law—all remains pretty much as Pococke saw it, suggesting the same idea as to him—that this strange interior once contained a sacred pond. To this day a fountain flows copiously in the near neighborhood. The French archæologists, moreover, have discovered two ruins of temples which had escaped the notice of all former explorers. They had been buried out of sight these centuries past in a swamp, covered with rhododendron-bushes; both were planted on large cubical masses of the living rock; each contained a niche or retreat, above which the water could never rise; on each side are vestiges of staircases, conducting to a platform above. In one, however, a singular variation from the ordinary form was detected—a beautiful frieze running round the monolithic walls; at either end a pair of immense sculptured wings, with a globe and an eagle's head, the former encircled by a number of asps entwined together with the tails of carnivorous birds. Here were also reached the foundations and even the upper outlines of sepulchral pyramids, containing "furnace-chambers," which M. Ernest Renan goes so far as to identify with the day and generation of the Prophet Job himself; but some of the edifices were scarcely pyramidal in the accepted interpretation of the term; they had circular basements, flanked with images of lions, and surmounted by cylindrical monoliths, seven or eight yards in height, crowned in their turn by superstructures in a very composite taste, giving some hint, however, of the crenellated ramparts that are reputed to have engirdled Babylon, and bearing a strong resemblance to the Koyoundjik relics to be seen at the Louvre. In some instances one pyramid is heaped on the summit of another, with colossal supports of stone sustaining the second weight, and ornaments somewhat grotesquely interspersed of alabaster slabs, colored or engraven, animal figures, and other objects which, in the judgment of the French antiquarian, might actually have been brought to this place from the valley of the Tigris or the valley of the Euphrates more than two thousand years ago.

There are bass-reliefs, too, entirely consonant the one with the other; legends of Isis and Hathor; lunar disks and bulls' horns. In presence of all this testimony, the French archæologists do not hesitate to affirm that, although they may not have dug among the ruins of those heathen temples, famous throughout the East in a remote era, to which the Scriptural allusions are made, here was the shrine of Adon—here was the Sanctuary of Baal, as stamped upon coins as engraven on gems. It is impossible, no doubt, to distinguish, at present, amid the blended multitude of relics turning up at each stroke of the excavator's ax; but it is enough to separate a Roman or Grecian from an Assyrian or Assyrian group—Adonis in the costume of a Latin Emperor, and Irapta in that of a Babylonian Queen. Still, after all, most of these investigations have, hitherto, been made comparatively speaking, on the surface. It is the subterranean Sidon that we may now expect to have brought to light the great Necropolis, discovered a quarter of a century ago, but never yet thoroughly explored, with its mummy-tombs, mummies not in the least resembling those which have been exhumed from Egyptian graves, indications, indeed, of a state of life and manners far different from those of the Nilosia rulers or people; in fact appearing to go beyond them and take us back to the earliest recorded annals of the human race. It is not pretended that the key to all these secrets, so intimately associated with our Biblical chronicles, has yet been found; but it is unquestionable that, even until the pulverization to which most of the ancient cities of Canaan have, through various causes, been reduced, portions may be fitted together, from fragments and inferences which may create for our imaginations something, at least like a restoration of that marvelous life which followed the primitive times, and illustrated itself in the buildings of cities, and temples, and dwellings for the poor and the rich. The recent French discoveries are principally interesting as a promise of others to come.—*Building News.*

NEW SPHEROMETER.

BEFORE the London Physical Society, recently, an improved form of spherometer, designed by Mr. W. Gooddand made by Mr. Adam Hilgar, was exhibited to the meeting. The frame is of aluminum, combining lightness and rigidity, the legs and screws of hard steel. The screw carries a disk divided into 1,000 parts, and the instrument gives a reading to the $\frac{1}{100000}$ of an inch by the usual method of touch. Increased sensitiveness is got by employing a galvanometer to indicate the contact of the middle pointer with the surface. By this means it is made correct to $\frac{1}{500000}$ inch. A smaller form of the instrument, correct to $\frac{1}{10000}$ inch, was also shown.

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